Oregon Health Authority

Final

Public Health Assessment
Highway 36 Corridor Exposure Investigation

Prepared by the

Environmental Health Assessment Program
Oregon Health Authority; Public Health Division

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Foreword

The Oregon Health Authority (OHA), in cooperation with state and federal partners, prepared this Public Health Assessment (PHA). The Agency for Toxic Substances and Disease Registry (ATSDR) and its Oregon cooperative agreement partner, the Environmental Health Assessment Program (EHAP), conduct public health assessments to evaluate environmental data and community concerns. Contained within this PHA are the results of the Highway 36 Corridor Exposure Investigation (EI). The EI was conducted in response to resident's concerns about potential exposures from pesticide applications occurring on forestlands near their homes and schools.

At an April 2011 Board of Forestry meeting, several residents announced the results of a community-led, urine sampling effort. The results showed elevated levels of atrazine and 2,4-D in their urine. The Oregon Department of Forestry (ODF) notified the Pesticide Analytic and Response Center (PARC) of the results. As co-chair of PARC, OHA joined a multi-agency workgroup to develop the Highway 36 Corridor Exposure Investigation (EI) in order to determine if people are being exposed to pesticides in the Highway 36 corridor, and if so, the health implications of these exposures.

For the purposes of this document, the following definitions apply:

Public Health Assessment (PHA):
A PHA is an evaluation tool of choice when a site contains multiple contaminants and multiple, potential pathways of exposure. PHAs are conducted in an effort to determine whether a community is being exposed to environmental contaminants at levels that could harm human health. PHAs are not the same as medical exams, community health studies[1], or epidemiological studies[2]. A PHA is focused on a specific site or community and its findings are not intended to be generalizable to other sites or communities. **Sometimes critical data needed for a PHA are missing or not available. In such cases, ATSDR may conduct an Exposure Investigation (EI).**

Exposure Investigation (EI):
An EI is one approach used to better characterize past, current and possible future human exposures and to evaluate both existing and possible exposure-related health effects. An EI involves the collection and analysis of environmental data and, when appropriate, biologic data (such as urine or blood). The goal of an EI is to determine whether people have been, or are being, exposed to hazardous substances. An EI is one of several possible approaches to characterize past, current and possible future human exposures to environmental contaminants. An EI is not an epidemiological study or experiment. As such, some components of other types of studies, such as control groups, are not included in an EI.

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[1] A community health study (CHS) requires careful methods of measuring exposure and illness. Diseases can be caused by many different factors. It may be difficult to determine if a disease is caused by exposure to contaminants and not due to these other factors. A CHS presents many challenges and they are rarely conducted in small communities.

[2] Epidemiology (epi) is the study of the incidence, distribution and determinants of disease. Various methods can be used to carry out epi investigations, including descriptive studies used to study distribution and analytical studies to study determinants. The four most common types of epidemiological studies are 1) a cohort study, 2) a case-control study, 3) an occupational epi study, and 4) a cross-sectional study.

This PHA reports on the results of the Highway 36 Corridor EI to date. It contains an analysis of information and data (qualitative, biologic and environmental) collected between April 2011 and September 2012. The EI findings are nested within the broader public health assessment process that ATSDR uses. Therefore, it is important to note that this PHA is the tool used to communicate the EI findings.

OHA serves as the lead agency for coordinating and implementing this investigation. Three other state agencies (which are members of PARC), and two federal agencies are involved in this effort. These agencies are:

- Oregon Department of Agriculture (ODA); Administrator of PARC
- Oregon Department of Forestry (ODF); PARC Member Agency
- Oregon Department of Environmental Quality (DEQ); PARC Member Agency
- Centers for Disease Control and Prevention (CDC)
    - Agency for Toxic Substances and Disease Registry (ATSDR) headquarters (Atlanta, GA) and Region 10 office (Seattle, WA)
    - National Center for Environmental Health (NCEH) laboratory (Atlanta, GA)
- U.S. Environmental Protection Agency (EPA)
    - EPA Region 10 (Seattle, WA)
    - EPA Office of Pesticides Programs (Washington, DC)
- PARC consultants from the Oregon Health and Science University (OHSU) and Oregon State University (OSU) also provide technical assistance and consultation for this investigation.

This group of agencies has provided input into the EI according to their areas of expertise and legal authority. For example, DEQ and EPA were responsible for collecting environmental data, and were key partners when writing pieces of the report related to the environmental samples. Each agency has reviewed the report and provided input, feedback and edits to the sections relevant to their agency. In addition, the group as a whole met several times to discuss issues as they arose and arrived at agreement on how to report the EI results. Funding and other staff resources used to conduct this EI was contributed by all state and federal agencies involved.

OHA Public Health Division (OHA/PHD) houses the Environmental Health Assessment Program (EHAP), which is the ATSDR-cooperative agreement program funded to carry out ATSDR's work in Oregon. EHAP staff are the primary authors of this report.

Purpose and Statement of Issues

This PHA reports on the available information and data collected to date for the Highway 36 Corridor EI. The Highway 36 Corridor is located in western Lane County, Oregon. The EI is a multi-agency response to several community members' requests to investigate possible exposures to pesticides and herbicides used in industrial forestland applications near their residences and schools. The purpose of the EI is to fill important data gaps by collecting and analyzing available information and environmental, biologic and qualitative data to answer the following questions:

1. Are residents in the Highway 36 Corridor being exposed to pesticides from local application practices?
2. If residents are being exposed:
    a. To what pesticides are they being exposed?
    b. To what levels are they being exposed?
    c. What are potential source(s) of the pesticides to which they are exposed?
    d. What are potential routes (pathways) of residents' exposures?
    e. What health risks are associated with these exposures?

As described in the "Background" and "Community Concerns" sections of this report, several Highway 36 Corridor residents are concerned about how these herbicide applications may be affecting their health. Therefore, this EI focuses on collecting and evaluating data on herbicides that are used in this area. Because "pesticide" is a more inclusive and commonly understood term, we use "pesticide" from this point forward to refer to herbicides, insecticides, fungicides, rodenticides and similar products regulated under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA).

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List of Abbreviations and Acronyms

2,4-D – 2,4-dichlorophenoxy acetic acid
ATSDR – Agency for Toxic Substances and Disease Registry
BE – Biomonitoring equivalent
CDC – Centers for Disease Control and Prevention
CS&R – Central Shipping and Receiving (at Emory University)
DACT – Diaminochlorotriazine, a metabolite of atrazine
DAAM – Di-dealkylated atrazine mercapturate, a metabolite of atrazine
DEA – Desethyl atrazine, a metabolite of atrazine
DEET -- N,N-diethyl-meta-toluamide is common ingredient in insect repellent
DEQ -- Department of Environmental Quality
EI – Exposure Investigation
EPA – U.S. Environmental Protection Agency
HOD – Health outcome data
g -- gram
L – liter
ODA – Oregon Department of Agriculture
ODF – Oregon Department of Forestry
OHA – Oregon Health Authority
OHSU – Oregon Health & Science University
OSU – Oregon State University
ng – nanogram
NCEH – National Center for Environmental Health
NHANES – National Health and Nutrition Examination Survey
µg – microgram
mg -- milligram
mL – milliliter
PARC – Pesticide Analytical Response Center
PHA – Public Health Assessment
PHLAN – PeaceHealth Laboratory Accession Number
ppb – parts per billion
ppm -- parts per million
PR – Pitchfork Rebellion
RfC – Reference Concentration
RfD – Reference Dose
SWG – Siuslaw Watershed Guardians

Summary

The Oregon Health Authority (OHA), in cooperation with state and federal partners, prepared this final report as part of an ongoing Exposure Investigation (EI) for the Highway 36 Corridor. OHA prepared this report under a cooperative agreement with the federal Agency for Toxic Substances and Disease Registry (ATSDR).

ATSDR's mission is to serve the public by using the best science, taking responsive public health actions and providing trusted health information to prevent harmful exposures and diseases related to toxic substances. OHA prepared this report in accordance with ATSDR's approved methods, policies and procedures existing at the date of publication.

Questions

The purpose of this EI is to answer the following questions:

1. Are residents in the Highway 36 Corridor being exposed to pesticides from local application practices?
2. If residents are being exposed:
    a. To what pesticides are they being exposed?
    b. To what levels are they being exposed?
    c. What are potential source(s) of the pesticides to which they are exposed?
    d. What are potential routes (pathways) of residents' exposures?
    e. What health risks are associated with these exposures?

As reported in this PHA, most of these questions have been answered to a limited degree. However, the investigation was not completed as planned, and uncertainties and data gaps remain. We recognize that the samples included in this report represent a snapshot in time and that air has not been adequately tested. In addition, most samples were collected during the time of year when pesticide use in the area was presumably at its lowest levels. The original plan was to conduct additional urine and environmental sampling immediately after pesticide applications occurred, in order to capture exposure conditions when pesticide levels in the environment (and presumably in people) would have been at their highest. The EI team was unable to do this additional sampling because of logistical challenges, which included changes to planned areas of application, the difficulty in collecting samples within 24-48 hours of an application and other issues. Because of the need for more data, and to overcome some of the logistical challenges, EPA is developing a passive air sampling method that will help answer questions about sources and routes of exposure (questions 2. c and d.). When the results of EPA's air monitoring become available, OHA will analyze, describe and report out on their public health significance.

Methods

OHA and its agency partners used qualitative and quantitative methods to carry out this EI. OHA analyzed information gathered from community meetings, interviews with residents, correspondences, and reviews of news stories and media coverage to describe the broad themes of community concerns. OHA and its agency partners also collected samples of urine, drinking water, soil, and homegrown foods from residents in the area during August and September of 2011.

In July and August of 2011, OHA recruited participants at community meetings and through phone calls, direct mailings, flyers, a toll-free number and a listserv. To be eligible to participate, volunteers were required to:

- live within 1.5 miles of a timber unit that had been harvested in 2010 or 2011,
- not be working as a pesticide applicator, and
- live within the defined exposure investigation area.

Homegrown foods, drinking water and soil samples were collected and analyzed for a list of pesticides that were being used in the area. All samples collected by OHA and partner agencies were intended as "baseline" samples, collected during the time of year when pesticide applications in the investigation area were presumably at their lowest levels.

Some members of the community living in this area conducted sampling of urine, surface water, and ambient air, independently of government agency oversight and at their own expense. The community-led urine sampling effort was carried out in the spring of 2011, and the water and air samples were collected at various times throughout 2011. Community-collected urine samples were sent to Dr. Dana Barr's laboratory at Emory University in Atlanta, GA, where they were analyzed for 2,4-D and atrazine. Community-collected air and water samples were analyzed by Anatek laboratory in Moscow, ID. Because these samples were collected by community residents and analyzed by non-governmental entities, OHA examined the quality control procedures of the sample collection and analysis and compared them with standards used by OHA and its agency partners, . The quality control procedures for the sample collection by the community and the analysis by the labs were determined to meet the standards used by OHA and its agency partners for inclusion in this report. Therefore, the conclusions and recommendations expressed here are based on data generated by both the EI team and the affected community members themselves.

Urine samples were analyzed for the presence of 2,4-dichlorophenoxy acetic acid (2,4-D)[3] and atrazine[4]. These are two pesticides used in forestry practices, for which there are laboratory methods developed to detect their presence in urine. Results of laboratory analyses for the urinary levels of 2,4-D were compared to data on 2,4-D levels found in the general US population, from the 2003-2004[5] National Health and Nutrition Examination Survey (NHANES). NHANES is a national survey designed to assess the health and nutritional status of the non-institutionalized US population. It is conducted by the federal Centers for Disease Control and Prevention (CDC).

No national comparison data are available for atrazine, because NHANES does not monitor for atrazine. The potential for health effects from the levels of 2,4-D detected in urine samples was determined by comparison against the acute and chronic biomonitoring equivalents (BE). The BE is the concentration of pesticide metabolites in urine that corresponds to the daily oral dose at which there is no known harm to health. No BE is available for atrazine.

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[3] For more information about 2,4-D see Appendix F of this document.
[4] For more information about atrazine, see Appendix F of this document.
[5] 2003-2004 are the most recent years of NHANES data that are publicly available

Water, soil and food samples were analyzed by the Oregon Department of Environmental Quality (DEQ) laboratory and the Oregon Department of Agriculture (ODA) laboratory. OHA compared measured concentrations of pesticides in water, soil, and homegrown foods against established health-based comparison values.

Results

Urine samples:
Urine samples collected by the community in the spring of 2011 were tested for 2,4-D and atrazine, the only two pesticides for which there are methods developed to test for in urine. The samples showed levels of 2,4-D that were statistically higher than the general U.S. population. In addition, all community-collected samples collected in the spring of 2011 contained detectible levels of atrazine metabolites.

As expected, the 66 urine samples collected by the investigation team in the fall of 2011had levels of 2,4-D that were not statistically higher than levels found in the general U.S. population. None of the samples collected by the investigation team in the fall of 2011 contained detectable levels of atrazine metabolites. These results were expected because the samples were collected during baseline conditions, when 2,4-D and atrazine use in the area was at its lowest levels.

In all samples, levels of 2,4-D were below the biomonitoring equivalent (BE) for 2,4-D. A BE is the concentration of a chemical in urine (or other biological sample such as blood) that corresponds to the daily oral dose at which there is insignificant risk of harm to health. There are no national reference values for atrazine metabolites available for the general population, and there is not a BE established for atrazine. Therefore, it is not possible to compare the levels of atrazine metabolites found in the community-collected urine samples to levels that are expected to harm human health.

Drinking water samples:
Three of the 36 drinking water samples collected had detectable amounts of DEET, fluoridone, or hexazinone. DEET is a commonly applied product found in bug repellants. Fluoridone is an aquatic pesticide used to control weeds in ponds and hexazinone is a broad-spectrum pesticide used to control weeds.

Soil samples:
Three of the 29 soil samples collected had detectable amounts of 2,4-D and/or glyphosate (the active ingredient in the weed killer Roundup®). The concentrations of pesticides found in both soil and water samples were not at levels high enough to cause harm to human health, including for children and other population groups who may be especially sensitive to pesticide exposure.

Homegrown and wild grown food samples:
No pesticides were detected in any of the homegrown or wild grown food products sampled in the fall of 2011.

Air samples:

One out of 16 air samples collected by community members in May of 2012 contained a low but detectable amount of clopyralid. Clopyralid is a pesticide commonly used to control weeds and woody brush on forestlands and areas next to rights of way.

Community Concerns:
OHA has identified several causes of stress and conflict within the Highway 36 community. These include: concern and anxiety about health and safety; differing beliefs about pesticide use; the lack of adequate spray notifications; difficulty in obtaining records of pesticide applications; anger and distrust of government agencies; and what is viewed as the protection of large timber and chemical company interests above community rights. Some community members are confident that governmental requirements for pesticide labeling and use are protective of health. Others are skeptical and want the government to do more to protect their health. Some community members have requested an aerial spray buffer zone be established around homes and schools, while others are calling for a complete moratorium on all uses of pesticides. Community conflict, stemming from these divergent views, has escalated to a level where community cohesion has been negatively affected.

Conclusions

As a result of this EI, OHA reached *twenty-two* important conclusions addressing the questions that serve as the framework for this investigation about the presence, type and source of exposure to pesticides in the Highway 36 investigation area.

OHA reached *one* conclusion related to the question:
Are residents in the Highway 36 Corridor being exposed to pesticides from local application practices?

> **Conclusion 1:** This investigation found evidence that residents of the investigation area were exposed to pesticides or herbicides in spring and fall 2011. However, it was not possible to confirm if these observed exposures occurred as a result of local application practices or were from other sources.
> *Basis for Decision:* The urine sample analysis showed exposure to 2,4-D and atrazine. Environmental sampling in fall 2011 identified low levels of additional herbicides and DEET in soil and some water samples. Only one of the pesticides measured in fall 2011 environmental sampling (2,4-D) was the same as the pesticide measured in urine. Concentrations of 2,4-D measured in fall environmental samples were too low to explain concentrations measured in urine. In Spring 2011, there were no environmental samples that could be used to definitively link urine concentrations to specific pesticide applications.

OHA reached *four* conclusions related to the question:
To what pesticides are they being exposed?

> **Conclusion 2:** Residents in the Highway 36 investigation area had urinary biomarkers for exposure to 2,4-D in spring and fall 2011, and atrazine in spring 2011. We were unable to determine if participants in the investigation had urinary biomarkers for exposure to pesticides other than 2,4-D and atrazine in spring or fall 2011.

Basis for Decision: OHA was unable to identify a laboratory that had the technical capability to test human urine samples for pesticides that are used in the area other than 2,4-D and atrazine.

Conclusion 3: Some Highway 36 investigation area residents may have been exposed to very low levels of DEET, fluoridone, or hexazinone in their drinking water.
Basis for Decision: DEQ detected very low concentrations of DEET, fluoridone, or hexazinone in three out of the 36 drinking water samples collected.

Conclusion 4: Some Highway 36 investigation area residents may have been exposed to very low levels 2,4-D or glyphosate in their soil.
Basis for Decision: ODA detected 2,4-D and/or glyphosate in three out of 29 soil samples collected.

Conclusion 5: Some Highway 36 investigation area residents may have been exposed to very low levels of clopyralid in the air.
Basis for Decision: One out of 16 air samples collected by community members in May of 2012 contained a low but detectable amount of clopyralid.

OHA reached *three* conclusions related to the question:
To what levels are they being exposed?

This investigation documented the presence of 2,4-D and atrazine in the urine of residents. There was a drop in those levels between the spring and fall 2011 for reasons that are currently unknown. There were no recorded applications of 2,4-D or atrazine in the months leading up to collection of these fall 2011 urine samples. However, 13 of the spring 2011 urine samples were also collected prior to any recorded 2,4-D or atrazine application and yet contained 2,4-D and atrazine metabolite concentrations significantly higher than the fall 2011 samples.

Conclusion 6: In the **spring of 2011**, Highway 36 investigation area residents had higher levels of 2,4-D exposure than the general U.S. population.
Basis for Decision: The concentrations of 2,4-D measured in the urine of participating Highway 36 investigation area residents in spring 2011 were statistically higher than those measured in the NHANES population. The NHANES population is representative of the general, non-institutionalized population of the United States.

Conclusion 7: In the **fall of 2011**, Highway 36 investigation area residents had urinary 2,4-D levels that were not statistically higher than the general U.S. population.
Basis for Decision: As expected, the concentrations of 2,4-D measured in the urine of participating Highway 36 investigation area residents in fall 2011, during the time of year when there were no reported 2,4-D or atrazine applications, were similar to those of the NHANES population. Measured concentrations were within the expected range as expressed by the NHANES 95th percentile. However, there was a slightly greater than expected number of participants whose urinary 2,4-D levels were in the upper quartile of the expected range. When compared to the NHANES 75th percentile the concentrations of 2,4-D in the urine of participating Highway 36 area residents were slightly higher with a difference that approached, but did not attain, statistical significance ($p=0.06$).

Conclusion 8: In the spring of 2011, urine samples from Highway 36 investigation area residents also had detectable levels of atrazine metabolites, but it is unknown how these levels compare to the general U.S. population.
Basis for Decision: The CDC did not test NHANES populations for the same metabolites of atrazine measured in participants of this EI. Without a reference population, it is not possible to determine how Highway 36 investigation area residents compare with other people with respect to urinary atrazine metabolite levels.

OHA reached *two* conclusions related to the question:
What are potential source(s) of the pesticides to which they are exposed?

Aerial and ground applications of 2,4-D, atrazine and other pesticides did occur in the investigation area in 2011. However, this investigation found that additional, unknown sources were a major contributor to the pesticides detected in participants' urinary 2,4-D and atrazine metabolite levels. In nine participants, four documented aerial applications possibly contributed additional increases in urinary atrazine metabolites, but not 2,4-D.

Conclusion 9: There are additional sources of 2,4-D and atrazine in the investigation area that are not accounted for in the pesticide application records available to the investigation team.
Basis for Decision: For the spring 2011 samples, there was no statistical difference in 2,4-D and atrazine metabolite levels between the 13 urine samples collected before any known applications and the 26 urine samples collected after any known pesticide applications. As a group, the 39 spring 2011 urine samples had statistically higher 2,4-D and atrazine metabolite levels than the 64 fall 2011 urine samples, which were all collected three months after the last known forestry application of 2,4-D or atrazine. The spring 2011 samples, including the 13 pre-application samples, were also statistically significantly higher than the U.S. population as represented by NHANES.

Conclusion 10: Statistical associations suggest that four local aerial applications of atrazine and 2,4-D to forestland may have contributed to an increase in urinary atrazine metabolite levels in samples collected from nine participants within 24 hours of those applications.
*Basis for Decision***:** The EI team did not collect any environmental samples around the time of spring 2011 urine sampling. However, urine samples collected from nine participants within 24-hours of four aerial applications of 2,4-D and atrazine to forestland had statistically higher levels of atrazine metabolites compared to the remaining 30 spring 2011 urine samples, but not 2,4-D. The four aerial applications took place within 2-4 miles of the residences of the nine EI participants with elevated atrazine metabolite levels. Because the investigation team did not have concurrent environmental samples detailing atrazine's persistence and distance traveled, we were unable to confirm that the known aerial applications were the source for the elevated atrazine metabolites that were detected in the nine residents' urine.

OHA reached *five* conclusions related to the question:
What are potential routes (pathways) of residents' exposures?

Low but detectable levels of DEET, fluoridone, or hexazinone were found in 8% of the drinking water samples. Glyphosate and/or 2,4-D were found in 10% of the soil samples. This suggests that in some cases incidental swallowing or absorption of pesticides from water or soil may be a path of exposure. No pesticides were found in the homegrown foods sampled, suggesting that this is an unlikely route of exposure.

Conclusion 11: We were unable to determine whether air is a pathway of exposure to pesticides in the Highway 36 investigation area.
Basis for Decision: Neither OHA nor the EI team members have had the funding or the staffing, logistical, technological or funding capacity to actively monitor air for the pesticides used in the area. Community-collected air samples were too few in number to provide the basis for eliminating or confirming air as a relevant exposure pathway.

Conclusion 12: Drinking water was eliminated as an exposure pathway for 2,4-D and atrazine in the fall of 2011. *Basis of Decision:* As expected, no 2,4-D or atrazine -or their breakdown products - were detected in any of the water samples collected in the fall of 2011 at a time when there were no reported applications of these pesticides.

Conclusion 13: Soil sampled in the fall of 2011 was eliminated as an exposure pathway for the 2,4-D and atrazine detected in Highway 36 investigation area residents' urine.
Basis for Decision: Concentrations of 2,4-D measured in two soil samples were far too low to explain the levels of 2,4-D found in Highway 36 investigation area residents' urine. In addition, most EI participants had detectable 2,4-D in their urine but no 2,4-D detectable in their soil.

Conclusion 14: Wild or homegrown food products sampled in the fall of 2011 were eliminated as an exposure pathway in the fall of 2011.
Basis of decision: No pesticides were detected in any of the wild or homegrown food samples collected.

Conclusion 15: Concentrations of pesticides in drinking water, soil and homegrown foods in the spring of 2011 and other seasons and years are unknown. *Basis of Decision:* Drinking water, soil and homegrown food samples were only collected in the fall of 2011, at a time of year when there were no reported 2,4-D or atrazine applications.

OHA reached *five* conclusions related to the question:
What health risks are associated with these exposures?

This investigation documented the presence of 2,4-D and atrazine metabolites in the urine of residents. However, the levels of 2,4-D found in residents' urine are below the levels currently known to be harmful to health. OHA cannot determine whether measured atrazine metabolite levels pose a health risk to residents. The levels of the pesticides found in the water, soil and food samples were at levels below which we would expect to see harmful health effects.

Conclusion 16: The levels of 2,4-D measured in Highway 36 investigation area residents' urine in spring and fall 2011 were below levels expected to harm people's health.
Basis for Decision: The concentrations of 2,4-D measured were lower than the biomonitoring equivalent (BE) for 2,4-D. The BE is a calculated urine concentration that corresponds to an oral dose of 2,4-D associated with no harm to health.

Conclusion 17: We cannot determine whether the levels of atrazine metabolites measured in Highway 36 investigation area residents' urine in spring 2011 could harm people's health.
Basis for Decision: Unlike 2,4-D, there is no BE for atrazine metabolites. Without a BE against which to compare urinary atrazine metabolite levels, it is not possible to determine how measured urinary concentrations relate to doses that cause harm to health.

Conclusion 18: Drinking or contacting domestic water with the concentrations of pesticides detected in some Highway 36 investigation area properties in fall 2011 is not expected to harm people's health.
Basis for Decision: Three of 36 drinking water samples collected in fall 2011 within the Highway 36 investigation area had detected concentrations of pesticides. The concentrations measured at the time of sampling were thousands of times lower than health-based comparison values. The measured levels were too low to harm the health of people who drink the water, including sensitive populations such as children.

Conclusion 19: Contact with soil containing pesticides at the concentrations detected in the fall of 2011 in some Highway 36 investigation area soil is not expected to harm people's health.
Basis for Decision: Three of 29 Highway 36 investigation area soil samples had measurable amounts of pesticides at the time of sampling. The concentrations measured at the time of sampling were thousands of times lower than health-based comparison values. Measured concentrations were too low to harm the health of people contacting the soil, including sensitive populations such as children.

Conclusion 20: Handling or consuming garden vegetables, berries, eggs, milk, or honey collected from the Highway 36 EI participants' homes in fall 2011 will not lead to harmful health effects related to pesticide exposure.
Basis for Decision: No pesticides were detected in any of the wild or homegrown food products sampled in the fall of 2011.

OHA reached *two* additional conclusions related to the impacts to the EI and to the health of community members from community conflict.

Conclusion 21: Divisions and hostility within the community related to pesticide use, property rights and land use are creating significant stressors on many individual community members and on the community as a whole.
Basis for Decision: OHA staff and other members of the EI team have observed, documented and responded to a high volume of complaints from a broad range of Highway 36 community members who express anger, frustration, mistrust, and fear. Community members express concerns about the intentions, motives and actions of others with opposing views on land use, pesticide use and property and human rights within and outside of their community.

Conclusion 22: Leadership activity within the community has been oriented toward debating issues of land use, pesticide use, and property rights. No formal or informal leader has yet emerged who has a mediating influence on these differences. Formal mediation services for the Highway 36 community may be necessary for both the successful completion of the EI and for the important progress needed to reduce community stress and improve community cohesion in the longer term.
Basis for Decision: Many community members have expressed frustration and concern about the degree and persistence of the conflict within their community and toward public agencies, timber industry practices and pesticide use. Regardless of the outcome of the EI, resolving these differences may be necessary to restore community cohesion.

Uncertainties and Limitations

As with any scientific investigation, there are uncertainties and limitations to our conclusions about exposure and health risks.

- **Fall 2011 environmental and urine samples were collected at a time when there were no reported 2,4-D or atrazine applications.** The EI team was not able to collect environmental or urine samples immediately after pesticide applications as planned due to unanticipated logistical challenges. Had samples been collected immediately after 2,4-D or atrazine applications, results might have better reflected conditions of high 2,4-D and atrazine use.
- **Household dust has not been evaluated as an exposure pathway.** Many pesticides are rapidly degraded in outdoor environments where they are exposed to sunlight, water and soil microbes. Indoor environments can shelter chemicals from these degrading forces, and pesticides may persist much longer indoors. Contaminants in soil tracked indoors on shoes can become part of household dust and persist much longer than would be predicted outdoors. This pathway has not been evaluated.
- **While community-collected urine and environmental samples are of sufficient quality to include in this PHA, these samples were not collected or analyzed with the same level of oversight as the fall 2011 samples collected by government agencies.** This difference in oversight resulted in some difficulties obtaining information about how and why participants were recruited, how and why sampling locations and times were selected, and what the creatinine levels in urine samples were. Creatinine is a natural component of urine that is used by doctors and scientists as a basic measure of kidney function. Creatinine levels fluctuate depending on how concentrated a person's urine is at the time of the sample. The samples OHA collected in the fall were adjusted for this difference, while the community-collected, spring samples were not.
- **Conclusions can only be drawn about the pesticides that were tested for in urine and environmental samples.** The urine samples collected in spring and fall 2011 were only tested for atrazine metabolites and 2,4-D. There were other pesticides used in the investigation area during the sampling times, but the only pesticides for which there are laboratory methods to test for in urine are 2,4-D and atrazine. The environmental samples collected in fall 2011 were tested for a wider range, but not an exhaustive panel, of pesticides. We cannot determine if, how and how much people were exposed to other pesticides at the time of sample collection. We also do not know what the health implications of any unknown pesticide exposures may be.

- **Conclusions about exposure and health risks only apply to the times and places where samples were collected by community members or the investigation team.** All urine and environmental samples represent a snapshot in time and space. Because 2,4-D and atrazine rapidly clear from the body, the levels of these chemicals in urine can only be used to assess recent (within 24-48 hours) exposures. The levels of pesticides detected in environmental samples only indicate the amounts present at the time of sampling, and do not indicate whether these levels have changed over time. We also cannot conclude if Highway 36 Corridor residents had past exposures to pesticides, if past or current exposures were from acute (short-term) or chronic (long-term) contact with pesticides, or if residents have had repeated exposures to pesticides over time.
- **It is not known if the EI resulted in changes to pesticide application practices in the investigation area, and therefore if exposure conditions have changed for Highway 36 Corridor residents.** It is unknown if pesticide applicators changed their pesticide application practices (i.e., application methods, locations, or types of pesticides used) after the EI was initiated. Any changes in local application practices will also change exposure conditions within the investigation area, and will make it difficult to fully answer the EI questions.
- **There is insufficient scientific evidence to determine the effect of exposure to multiple pesticides at low doses.** There is a limited but growing body of scientific evidence on the health effects from exposure to multiple pesticides; however, current methods do not allow for a determination of risk resulting from exposure to multiple chemicals.

Next Steps

Pertaining to the results of this EI, OHA recommends that:

1. US EPA work with the EI team on developing a sampling and analysis plan designed to evaluate exposures to pesticides in air and to address gaps in the data needed to answer EI questions. At the time of publication of this report, passive air monitoring over several application seasons appears to be the best option to collect community-wide air data.
2. ODA and ODF continue to provide pesticide application data as needed to interpret air sampling (or other) data collected as part of this investigation.
3. State and federal agencies involved in the ongoing EI develop an implementation plan that includes identification of necessary resources to carry out activities appropriate for each agency's role in this effort.

Pertaining to broader and/or longer-term issues identified by the EI, OHA recommends that:

1. State agencies continue to collaborate on determining best practices that would protect human populations from pesticide exposures.
2. ODA and ODF work with pesticide applicators to develop consistent pesticide application record-keeping processes to ensure that application record data are accurately maintained and usable.
3. State agencies explore the feasibility of implementing a system that would allow people to be notified of imminent pesticide applications in such time and with such specificity that they could take action to avoid exposure to those applications. Such policies could include adoption of

systems developed by other jurisdictions or modification of existing regulatory systems designed to monitor pesticides applications.

4. State and federal agencies involved in the ongoing EI develop an implementation plan to address these recommendations, including the identification of resources to carry out activities appropriate for each agency's role in serving the communities of Oregon. That plan should include a recommendation on how the agencies should coordinate, collaborate and share resources.
5. Community members, including local elected officials and other community leaders, consider seeking the assistance of a professional mediation group to address immediate and long-term conflict within the community and identify actions to move this conflict toward resolution.

OHA will:

- Work with state and federal partners, community members, and other stakeholders to implement the recommendations in this report.
- Provide updates through the Highway 36 web page and listserv about findings from:
    - The comparison of application records from 2011 to application records from 2009 and 2010 to determine if there were noticeable (substantial) changes in pesticide application practices after the EI was initiated in 2011.
    - Air sampling data once it is collected by the EPA.

Background

Investigation Area

The EI area includes the following Township-Ranges: 15S 06W, 15S 07W, 16S 06W, 16S 07W, 16S 08W, 17S 07W, 17S 08W, and 17S0 9W (Figure 1). The investigation area covers approximately 286 square miles (182,990 acres) in western Lane County and encompasses most of the communities along the Highway 36 Corridor.

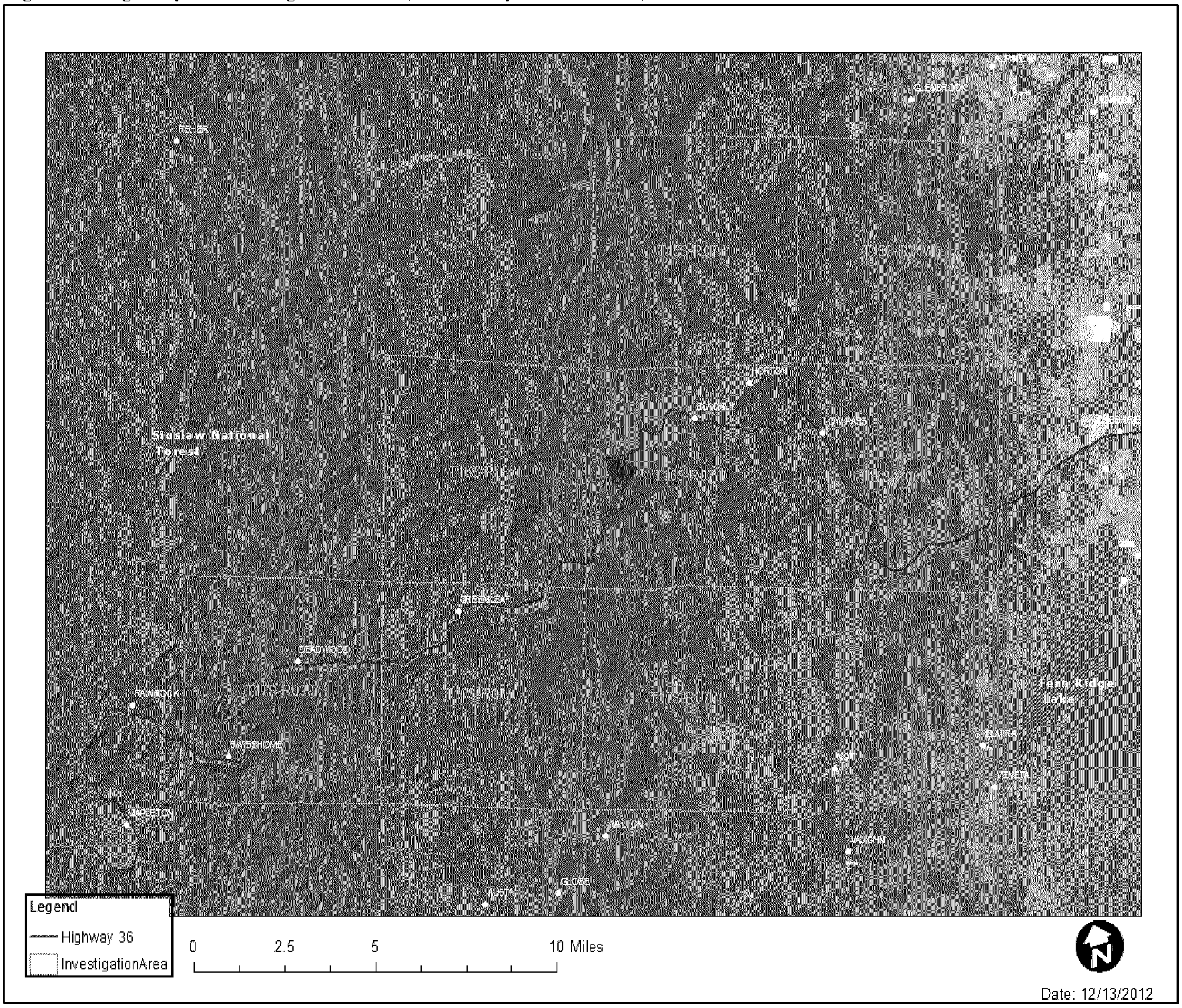
Recruitment Area

OHA established focused participant recruitment areas based on the proximity of residences to timber units that had been harvested in 2010 or 2011. All participants lived within the investigation area and within 1.5 miles of a 2010 or 2011 clear-cut.

Site Description

The investigation area is situated along a portion of Oregon state route 36 (Highway 36 in this report), which is a 52 – mile highway between the towns of Junction City and Mapleton in western Lane County. The Oregon Department of Transportation manages the highway and right of way. The investigation area includes the rural communities of Swisshome, Deadwood, Greenleaf, Triangle Lake, Blachly, Horton, and Low Pass. Approximately 2,161 people live in the investigation area. Approximately 1% (2,505 acres) of land in the investigation area is classified as rural residential. Approximately 5% (7,273 acres) is classified as agricultural land. According to the Oregon Department of Agriculture (ODA), agricultural production in the area includes pasture, hay, Christmas trees, small fruits, vegetables, and tree fruits. Forestry represents the majority of the land use in the investigation area and comprises approximately 95% (173,152 acres) of the classified use. Approximately half of the forestland in the investigation area is publicly owned, 25% is designated as privately owned industrial (ownerships greater than 5,000 acres) land, and the remaining 25% is designated as private non-industrial (ownerships less than 5,000 acres) [1]. Although forestry comprises 95% of the land use within the investigation area, land use percentages outside the investigation area vary dramatically, particularly to the east near Junction City, Eugene, and Harrisburg.

Figure 1. Highway 36 investigation area (shown in yellow outline).



Investigation History

Within the Highway 36 Corridor, there are residential properties located near forest, agricultural, or other residential lands where landowners may use pesticide products to control unwanted vegetation. Since 2005, some Highway 36-area residents have expressed concerns to Oregon state agencies about the human health and environmental effects from pesticide applications on nearby forest and agricultural lands. These residents have been advised by a consulting agronomist that the local geography and climate increase the likelihood of drift and re-volatilization of these pesticide applications to nearby residences and farms [2]. They have expressed a specific concern about aerial pesticide applications on harvested timberlands.

In 2005, a group calling itself the Pitchfork Rebellion (PR) began requesting that ODA address their concerns about alleged pesticide exposures from local application practices. In addition to being the

State's regulatory authority for pesticides, ODA administers the Pesticide Analytical Response Center (PARC). PARC is a multi-agency group with responsibilities to "centralize receiving of information relating to actual or alleged health and environmental incidents involving pesticides" and "mobilize expertise necessary for timely and accurate investigation of pesticide incidents and analyses of associated samples" [3].

In early 2010, PR petitioned the U.S. Environmental Protection Agency (EPA) to "conduct an unbiased study to determine what would be an appropriate aerial spray buffer zone for the specific conditions found along the Highway 36 Corridor in Lane County, Oregon" [4]. During a meeting with EPA Region 10 staff in April 2010, PR members reported instances of illnesses that they attributed to exposure to pesticides applied to forestlands near their homes [5]. In September 2010, EPA Region 10 requested the Agency for Toxic Substances and Disease Registry's (ATSDR) assistance in evaluating and addressing the health concerns raised by these residents and other organizations concerned about aerial pesticide applications on forestlands. In the winter of 2010, ATSDR Region 10 reviewed available information on illness reports and concerns from the area, conducted a site visit, and evaluated options to respond to local health concerns.

In spring 2011, 43 Highway 36 Corridor residents had their urine tested for pesticide metabolites by a researcher from Emory University (Atlanta, Georgia).[6] Based on the residents' assumption that aerial pesticide applications were the source of their health complaints, some community members collected urine samples both before and after aerial pesticide applications near their homes.

In April 2011, the researcher and a PR representative reported some of the community-collected urinalysis results at an Oregon Board of Forestry meeting. According to the presenters, the data indicated that:

- All of the submitted urine samples had detectable levels of 2,4-dichlorophenoxy acetic acid (2,4-D) and the atrazine metabolite diaminochlorotriazine (DACT).
- The researcher's presentation slides include a graph that compares purported "pre-spray" and "post-spray" 2,4-D and atrazine levels in participants' urine to the "U.S. population" which indicates higher levels in the local samples compared with the comparison.
- Some individual results showed that the 2,4-D and DACT levels in "post-spray" samples were higher than the levels found in "pre-spray" samples. The presenters ascribed the increase in concentrations to aerial applications on private forestlands. [7]

Shortly after these data were presented publicly, the Oregon Department of Forestry (ODF) notified PARC of information regarding actual or alleged health incidents involving pesticides in the Highway 36 Corridor. PARC agencies (OHA, the Department of Environmental Quality [DEQ], ODA, ODF, PARC consultants), ATSDR Region 10, and EPA Region 10 joined to form the Highway 36 Corridor EI team. The Governor's Office designated OHA as the lead state agency for the EI.

[6] See Appendix D for details on how spring 2011 urine samples were collected and tested. See the community-collected urine data section for OHA's interpretation of these data.

[7] The slides do not indicate the source of the "US comparison group", the total number of samples submitted, the numbers of "pre-spray" and "post-spray" samples, or the dates on which the samples were collected.

At the beginning of the investigation, the EI team did not have access to the biological sampling data presented at the April 2011 Board of Forestry meeting. Although some community members suspected aerial applications to forestlands, the investigation team broadened the investigation to evaluate local pesticide application practices and several potential exposure routes. This decision was supported by the presence of elevated 2,4-D and atrazine levels in all community-collected urine samples and not just those collected after a purported aerial pesticide application on forestland. The data presented in April 2011 suggested that residents could have chronic (or continuous) exposures to pesticides, possibly through contaminated drinking water or another source of exposure. The observed increase in 2,4-D and atrazine metabolites between first and second samples indicated there could also be acute (or short-term) exposures to pesticides after a nearby application. The investigation team chose a methodological approach to evaluate chronic and acute exposures from any local exposure source or pathway.

The EI team also began an extensive effort to open and maintain an active dialog with all of the residents in the investigation area. In keeping with ATSDR's approach to work with affected communities during an investigation, the EI team used a broad range of methods and venues to communicate with community residents, elected officials, industrial landowners, non-governmental organizations, trade organizations, technical experts, and other stakeholders. This communication effort was designed to provide community members with a variety of opportunities to receive information and share their thoughts and concerns about the investigation. It also provided the EI team important access to a broad range of community perspectives, as well as information on factors that could affect the design and implementation of investigation activities.

Discussion

Exposure Pathway Analysis

At the beginning of the EI, OHA conducted an exposure pathway analysis to identify the major pathways by which people could be exposed to pesticides in the Highway 36 Corridor. Exposure, which is defined as contact between a person and a chemical, can only occur if all of the following elements are present:

- a chemical source or released into the environment,
- a way or medium in which the chemicals move in the environment (e.g., water, soil, air, food),
- an exposure point or location where people come into contact with the chemicals,
- an exposure route by which people have physical contact with the chemicals (breathing it in, swallowing it, etc.), and
- an exposed population that comes into contact with the chemicals [6].

Scientists categorize exposure pathways as complete, potential, or eliminated based on their analysis of these five elements. In a complete exposure pathway, all five of these elements are present, indicating a strong likelihood that people could be exposed to a chemical. In a potential exposure pathway, one or more of the elements may be absent, but additional information is needed before eliminating or confirming the pathway. In an eliminated exposure pathway, exposure to a chemical is unlikely because at least one of these elements is absent. Scientists also attempt to determine if exposures occurred in the past, present, and/or future.

At the beginning of the EI, OHA identified five potential pathways by which Highway 36 Corridor residents could be exposed to pesticides in the environment (Table 1). OHA considered these "potential" pathways because at the outset of the investigation there were no environmental data to identify or rule out possible sources or pathways. OHA did not evaluate exposure to pesticide residues on food from retail grocery stores. While this is a valid and probable exposure pathway for many Highway 36 Corridor residents, it does not represent a unique local pathway that distinguishes this group from the general U.S. population. OHA also did not evaluate exposures to pesticides that occurred outside the investigation area. It is likely that many residents leave the study area periodically, which could cause them to be exposed to pesticides from uses other than those common to the investigation area.

Household dust is an additional potential exposure pathway that was not originally considered or evaluated in the EI. Many pesticides are rapidly degraded to less toxic byproducts in outdoor conditions where they are exposed to sunlight, water and soil microbes. In indoor environments, pesticides may be sheltered from these degrading forces and persist much longer [7], [8]. Studies have demonstrated that 2,4-D applied outdoors can be tracked indoors[9], [10]. The lack of indoor sampling standard methods and other logistical challenges makes it difficult to evaluate this pathway.

Table 1: Potential Exposure Pathways at the beginning of the Highway 36 Exposure Investigation.

Pathway	Source/Release*	Transport in environment (Media)	Point of Exposure	Route of Exposure	Exposed Population	Time
Air-borne particles	Aerial applications of pesticides and pressured ground sprays	Movement (drift) of chemicals off application sites (Air)	Outdoor air, indoor air	Breathing in chemicals in air	People who live or work near application areas	Past, present, future
Volatilized chemical vapors	Applications of pesticides	Volatilization of chemicals from soil to air (Air)	Outdoor air, indoor air	Breathing in chemicals in air	People who live or work near application areas	Past, present, future
Surface Soil	Applications of pesticides	Deposition of chemicals on surface soil (Soil)	Soil in gardens, yards	Swallowing, absorbing through skin	Gardeners, farmers, outdoor workers who have contact with surface soil	Past, present, future
Home-grown foods	Applications of pesticides	Deposition on, or uptake of, chemicals in garden vegetables, milk, eggs, etc. (Food)	Garden vegetable, milk, eggs, etc.	Eating	People who eat home-produced foods	Past, present, future
Drinking water	Applications of pesticides	Movement of chemicals through soil to groundwater or over land to surface water (Groundwater, surface water)	Tap	Drinking	Residents and other people who drink water from private ground/surface water sources	Past, present, future

*Aerial applications are primarily used on industrial forestlands in the Highway 36 Corridor. Ground applications include backpack spraying, "hack and squirt" applications, or roadside spraying by industrial or commercial landowners, government agencies, or private individuals.

Investigation Design

The EI team developed an investigation plan to evaluate the five potential exposure pathways and answer the EI questions. The EI team proposed to collect data during at least two sampling events: one in fall 2011 and one in spring 2012. The EI team implemented the fall 2011 sampling plan [11]; this report discusses the corresponding methods and results. The EI team was unable to implement the spring 2012 sampling plan for reasons discussed in the "Spring 2012 Sampling" section below.

The EI team designed the fall 2011 sampling protocol to collect information about pesticide sources and exposure pathways, except air, under baseline or low pesticide use conditions. The spring 2012 sampling plan was intended to evaluate the air exposure pathway during spring aerial or ground spray pesticide applications. As part of the spring 2012 phase, the EI team planned to collect urine samples before and after a nearby aerial or ground spray pesticide application and collect air monitoring data during one or more pesticide applications.

A note about EIs: EIs are not the same as epidemiological health studies and lack some key features commonly associated with epidemiological studies. For example, EIs are intentionally biased to seek out and test those individuals (or locations) expected to be most highly exposed (or contaminated). EIs are not randomized studies. EIs also do not identify or test control groups for comparison. This focuses all sampling resources on individuals at highest risk for exposure to and/or harm from environmental chemicals. EI results are not generalizable to populations outside of the ones tested in the investigation.

Fall 2011 Sampling

In August and September 2011, OHA, ATSDR, EPA and DEQ collected urine and environmental samples to evaluate if residents were being exposed to pesticides through drinking water, soil, and homegrown food. OHA recruited 66 participants from 38 households using the following methods [11]:

- During a public meeting on July 14, 2011, OHA provided attendees with a flyer containing information on how to volunteer for the Fall 2011 sampling event. OHA sought assistance from local community members to circulate this flyer through several informal community networks and post it at prominent public locations throughout the community.
- OHA contacted people who signed in at the July meeting by phone and email. OHA also encouraged community members to give our contact information to other interested residents.
- OHA established a toll-free hotline dedicated to the recruitment of volunteers.
- OHA established a listserv to announce updates on the EI and to recruit more volunteers.

The criteria for participation in the EI were that volunteers lived inside the boundaries of the investigation area, lived within 1.5 miles of a timber unit that had been clear-cut in 2010 or 2011 and did not work as a pesticide applicator.[8]

ATSDR and OHA staff collected 66 urine samples from 38 households on August 30 and 31, 2011. The samples were immediately frozen on dry ice and then shipped overnight to the Centers for Disease Control and Prevention's (CDC's) National Center for Environmental Health (NCEH) laboratory in Atlanta, Georgia. Samples were tested for 2,4-D and atrazine[9] metabolites. These two pesticides were the focus of the EI's urine analysis for three reasons:

1) these pesticides were used in local agricultural and forestry applications;
2) the CDC has laboratory methods to test for these chemicals and national reference levels against which to compare the results for 2,4-D; and
3) these chemicals were tested in the spring 2011 community-collected urine samples.

EPA and DEQ staff collected drinking water, soil, and homegrown and wild food samples from the same 38 households on September 19 – 22, 2011. DEQ's laboratory in Hillsboro, Oregon analyzed the drinking water samples for a broad range of pesticides (see Appendix C for the complete list). All other environmental samples, including food and soil, were analyzed at the ODA laboratory in Portland, Oregon for pesticides used in both agricultural and forestry applications. DEQ and ODA laboratories used EPA-approved methodologies and quality assurance protocols [12]–[19].

Fall 2011 Urine and Environmental Sampling Results

Urine Results

The urine samples collected in fall 2011 were analyzed for 2,4-D and atrazine metabolites, and the results were compared to data from the CDC's *Fourth National Report on Human Exposure to Environmental Chemicals* [20]. These national comparison data were collected as part of NHANES, a nationwide survey that includes monitoring for environmental chemicals in human blood and urine. NHANES is the best source of biomonitoring reference values for the general U.S. population because it is representative of the civilian, non-institutionalized U.S. population in terms of age, sex, and race/ethnicity. However, NHANES data may not reflect variations due to geographic location, season, or residence in urban versus rural areas [21].

These results were originally reported by ATSDR in the first formal report for the Exposure Investigation, *"Exposure Investigation: Biological Monitoring for Exposure to Herbicides, Highway 36 Corridor , Lane County, Oregon"*[21] released in March 2012. ATSDR's earlier report compared the EI urine results to NHANES values from 2001-2002; these were the most current NHANES data available at the time that report was released. In this current report, we compared the fall 2011 urine results against NHANES data collected in 2003-2004. Our use of 2003-2004 NHANES reference data explains the difference between this report's findings and the findings in the separate ATSDR report on the fall

[8] According to ODF, these units were most likely to be treated with pesticides during the fall 2011 and spring 2012 spray seasons. In the original investigation plan, OHA planned to collect urine and environmental samples from the same participants and households in fall 2011 and spring 2012.
[9] See Appendix E for general information on 2,4-D and atrazine.

2011 urine samples. The 2003-2004 NHANES values used in this report are slightly higher than the 2001-2002 values.

None of the 66 EI participants had detectable concentrations of atrazine or its metabolites in their urine, indicating there were no recent exposures at the time of testing. Of the 64 EI participants over the age of six[10], 59 (92%) had detectable levels of 2,4-D in their urine. The 95th percentile of the EI participants was not statistically different than the 95th percentiles of the NHANES populations tested in 2003-2004 (Table 2). These were the expected results since samples were collected at a time when no known applications of 2,4-D or atrazine were occurring in the investigation area.

Table 2: Summary of urine results for 2,4-D from fall 2011 sampling.

Units	Mean	Median	Geometric mean	Range	95th percentile of EI (CI)	95th percentile of 2003-2004 NHANES (CI)
µg/L	1.14	0.33	0.37	<LOD -29.98	1.39 (0.98-29.98)	1.63 (1.31-2.37)
µg/g creatinine	1.15	0.37	0.4	<LOD -37.33	1.46 (0.92-37.33)	1.58 (1.24-2.34)

EI – Exposure Investigation; CI = 95% confidence interval; LOD = Limit of Detection (0.1 µg/L for EI); NHANES = National Health and Nutrition Examination Survey; µg/L = micrograms per liter; µg/g; micrograms per gram

Three EI participants had creatinine-adjusted[11] urinary 2,4-D levels above the 2003-2004 NHANES 95th percentile (Table 3); this number was not statistically significant at the 95% confidence level and suggests that the range of 2,4-D levels is similar to the general population. Twenty-two EI (34.4%) participants had creatinine-adjusted urinary 2,4-D levels above the NHANES 75th percentile. The number of participants above the NHANES 75th percentile is not statistically significant at the 95% confidence level (alpha=0.05) but is significant at the less conservative 90% confidence level (alpha = 0.1). The marginally significant result when comparing to the NHANES 75th percentile indicates that there may be slightly more participants than expected in the upper quartile of the expected range of creatinine-adjusted urinary 2,4-D.

[10] There are no NHANES values for comparison for children under six years old.

[11] Contaminant concentrations in urine are influenced by the hydration status and kidney function of the person who provided the sample. In many studies, these factors are controlled by relating contaminant levels to the amount of creatinine measured in urine. Creatinine is a urinary by-product of protein metabolism that is filtered by the kidney at a known and predictable rate. Urinary creatinine levels can vary greatly from person to person and depend on the individual's age, sex, body mass, and other factors [22].

Table 3: Fall 2011 creatinine-adjusted urine results for 2,4-D compared against NHANES 95th and 75th percentiles.

NHANES percentile level	EI urine results above NHANES percentile		One Sample binomial test	
	Number	Percent	95% Exact CI	Two-sided Exact p-value*
95th	3	4.7%	0 – 9	0.60
75th	22	34.4%	22.7 – 46.0	0.06

CI = 95% confidence interval; NHANES = National Health and Nutrition Examination Survey; EI = Exposure Investigation
*Typically, a p value equal to or less than 0.05 is considered statistically significant.

To evaluate the health significance of the urinary 2,4-D levels in EI participants, we compared the urine results to the biomonitoring equivalent (BE) for 2,4-D. A BE represents the estimated concentration of 2,4-D that would be present in the urine of a person who was chronically exposed to 2,4-D at a dose equal to EPA's reference dose (RfD) for 2,4-D. An RfD is an estimate of the daily oral exposure that people (including sensitive populations) could be exposed to over a lifetime without experiencing harmful health effects. The BE for chronic exposures (lasting more than 7 years) to 2,4-D is 200 µg/L; for acute exposures (lasting one day), the BE is 400 µg/L for women of reproductive age and 1,000 µg/L for the rest of the population [23], [24].

The maximum concentration of 2,4-D detected in an EI participant (30 µg/L) was about seven times lower than the chronic BE, and between 13 and 33 times lower than the acute BE for women of reproductive age and the general population respectively. The average 2,4-D concentration measured in EI participants' urine (1.14 µg/L) was 175 times lower than the chronic BE, and more than 350 times lower than the acute BEs. These data indicate that at the time of testing, EI participants were not exposed to 2,4-D at levels known to cause adverse health effects from acute or chronic exposures. The weight of available scientific evidence indicates that the 2,4-D levels measured in EI participants' urine do not pose public health risks.

Environmental Sampling Results

EPA, with assistance from DEQ, collected environmental samples, which included drinking water, soil, and community grown food samples from participating households. Thirty-six drinking water samples were collected from EI participants' homes. Nineteen of these samples were from domestic wells and 17 samples were from springs. A surface water sample was also collected from nearby Little Lake, which is not used as a drinking water source. EPA and DEQ collected 29 soil, 14 vegetation, four berry, four egg, two milk, and two honey samples from participating households. DEQ analyzed each water sample for over 100 chemicals (analytes), and ODA's lab analyzed all other samples for 11 analytes used in agricultural and forestland applications in the area. Appendix C includes the list of analytes tested for in environmental samples.

Pesticides were detected in three (one analyte in each sample) of the 36 drinking water samples (Table 4). The three analytes detected were N,N-diethyl-meta-toluamide (DEET), hexazinone, and fluridone.

DEET was also detected in the sample collected from Little Lake. Each of these detections was below health-based screening values for these three chemicals. DEET is the active ingredient in many personal-use insect repellent products [25]. Hexazinone is an herbicide used to control a broad spectrum of weeds including undesirable woody plants in alfalfa, rangeland and pasture, woodland, pineapples, sugarcane, and blueberries. It is also used on ornamental plants, forest trees, and other non-crop areas [26]. Fluridone is an herbicide used to control aquatic weeds in ponds and lakes. Hexazinone is the only analyte detected that was listed in investigation area forest application notifications between 2009 and 2011.

The ODA lab detected at least one of the eleven pesticides in three of the 29 soil samples analyzed. Glyphosate and 2,4-D were both detected in one soil sample, and only 2,4-D or glyphosate was detected in the two other soil samples. The glyphosate and 2,4-D levels in these samples were below ATSDR's health-based screening values, which are 5,000 ppm for glyphosate and 500 ppm for 2,4-D (Table 4). None of the households with pesticides detected in their soil had any detectable pesticides in their drinking water. No pesticides were detected in any of the vegetation, berry, egg, milk, or honey samples collected in fall 2011.

Table 4: Fall 2011 environmental sampling results – detections in water and soil.

Location	Sample Type	Analytes Detected	Analyte Concentration (ppm)	Health-based Screening Value (ppm)	Source of screening value
Household 1	Domestic well water	DEET	0.0000047	0.2	Derived*
Household 2	Domestic spring water	Hexazinone	0.000183	0.2	HBSL
Household 3	Domestic well water	Fluridone	0.000031	0.4	HHBP
Little Lake	Surface water	DEET	0.0000058	1	Derived*
Household 4	Soil	Glyphosate	0.081	5,000	RMEG
	Soil	2,4-D	0.046	500	RMEG
Household 5	Soil	2,4-D	0.014	500	RMEG
Household 6	Soil	Glyphosate	3.3	5,000	RMEG

ppm = parts per million; DEET = *N,N*-Diethyl-3-methylbenzamide; HBSL = U.S. Geological Survey Health Based Screening Level; HHBP = U.S. Environmental Protection Agency Human Health Benchmark for Pesticides; RMEG = Reference dose Media Evaluation Guide; 2,4-D = 2,4-dichlorophenoxy acetic acid
* Derived using Agency for Toxic Substances and Disease Registry methodology and Reference Dose developed by Minnesota Department of Health (0.33 mg/kg-day)

Survey data

After urine samples were collected on August 30 and 31, 2011, OHA asked EI participants to complete a short survey on their pesticide use at home and place of work (see Appendix D for survey questions). Most EI participants were sent the survey via email and a few without internet access were contacted by phone. Forty-four (67%) of the 66 EI participants responded to the survey. Of the 44 respondents, 26 (59%) reported they did not use pesticides on their own land. Of the 18 who reported using pesticides on their land, a few respondents specified that they used Roundup® (active ingredient glyphosate), Weedmaster® (active ingredients 2,4-D and dicamba) or Crossbow® (active ingredients 2,4-D and triclopyr). Four (9%) survey respondents reported using pesticides at their place of work, and two of these four respondents had not used pesticides at work for the past several months. In the week prior to having their urine collected by ATSDR, none of the 44 survey respondents reported using pesticides at home or at work.

Comparison to Application Record data

OHA reviewed the available 2011 pesticide application data provided by ODF and ODA to determine if any commercial, public or private pesticide applications occurred during the fall 2011 urine or environmental sample collections.[12] The only reported commercial applications using 2,4-D or atrazine occurred in April, May, and early June, approximately three months prior to the urine testing (see Appendix B). Just prior to urine sample collection there were two aerial pesticide applications in the investigation area (August 28 and 29), however neither of these applications included 2,4-D or atrazine as active ingredients and would not have influenced urine sampling results. Two ground-based applications occurred during the urine sample collection (August 30th and 31st) and were as close as 0.3 miles to a participating household. The first application occurred on August 30 and used glyphosate, sulfometuron methyl, metsulfuron methyl, and imazapyr. The second application was a hack and squirt application on August 31 that used imazapyr. Neither of these applications used 2,4-D or atrazine (the chemicals that were tested in urine).

There were 13 reported pesticide applications on the days EPA and DEQ collected environmental samples (September 19-22). Eight applications occurred on September 20th, six of which were aerial applications on forestland. The eight applications on September 20th used the pesticides glyphosate, sulfometuron methyl, metsulfuron methyl, and imazapyr. One of these six aerial applications was as close as 1.1 miles from a participating household; the water, soil and vegetable samples collected from this household on September 22nd did not have pesticide detections. There were three applications of imazapyr on September 21st, one application of imazapyr on September 22nd, and one application of aminopyralid on September 22nd. The applications on September 21st and September 22nd were ground-based and located more than three miles from participating households.

Integration of Fall 2011 Data

Seven individual participants (in six households) who provided urine samples had pesticides detected in either their soil or drinking water (see Table 5). Two of these environmental samples had detections of 2,4-D, which was the only pesticide found in urine. The number of detections in environmental samples

[12] OHA obtained records of pesticide applications in the investigation area from 2009 – 2011, but only evaluated records from 2011 for this report. See Appendix A for additional information on 2011 application record data.

is too small to determine if there is a correlation between the 2,4-D levels measured in soil and the 2,4-D levels measured in urine.

The EI team cannot determine the sources of the pesticides detected in the fall 2011 drinking water or soil samples. In the survey administered by OHA shortly after the urine sample collection, all but one of the seven households with environmental sample detections reported using some kind of herbicide on their own property on a somewhat regular basis. Where specific products were named, Roundup® (active ingredient glyphosate) and Crossbow® (active ingredients 2,4-D and triclopyr) were the two most frequently used. However, none of the participants in these households reported using any pesticide products in the week prior to the urine sample collection. Further, application records indicate that none of the 13 known pesticide applications that occurred when EPA was collecting environmental samples contained the pesticides that were detected in drinking water (DEET, hexazinone, and fluridone). During the time the soil samples were collected, there were eight local pesticide applications that used glyphosate, which was detected in two households' soil samples. These applications were over three miles from these households, but some evidence suggests that under certain conditions some pesticides can travel long distances [28]–[35].

Table 5: Combined Urine and Environmental Data from Fall 2011 sampling.

Household	Participant	Urine 2,4-D (µg/g-creatinine)	Drinking Water (ppm)	Soil (ppm)
Household 1	Participant A	0.29	DEET: 0.0000047	Non-Detect
Household 2	Participant B	0.61	Hexazinone: 0.000183	Non-Detect
Household 3	Participant C	0.24	Fluridone: 0.000031	Non-Detect
Household 4	Participant D	37.3	Non-Detect	Glyphosate: 0.081 2,4-D: 0.046
	Participant E	0.94		
Household 5	Participant F	0.38	Non-Detect	2,4-D: 0.014
Household 6	Participant G	1.12	Non-Detect	Glyphosate: 3.3

µg/g = micrograms per gram; ppm = parts per million; 2,4-D = 2,4-dichlorophenoxy acetic acid; DEET = *N,N*-Diethyl-3-methylbenzamide

Uncertainties/Limitations

All scientific processes involve some uncertainties. This section discusses some of the uncertainties and limitations related to the fall 2011 sampling and results.

- All samples collected in fall 2011 (urine, water, soil, and food) represent snapshots in time, during a period when no known applications of 2,4-D or atrazine had occurred in several months. This is especially true for urine results since 2,4-D and atrazine are cleared rapidly from the body [31], [36], [37]. As such, any conclusions about exposure and health risks based on urine results only apply to the times these samples were collected.

- The results of fall 2011 sampling do not tell us whether EI participants had past chronic, acute, or repeated acute exposures to 2,4-D or atrazine. Chemical exposures are typically more harmful the longer they last. An ongoing (chronic) exposure may be more concerning than a short-term (acute) exposure even if the short-term exposure is more intense (i.e., greater amount of a chemical enters the body).
- We do not know if participants' urine contained other pesticides at the time of sample collection since we were only able to test for 2,4-D and atrazine metabolites in urine.
- Currently, there is little scientific information about the health implications of exposure to multiple chemicals at low doses.

Summary of Fall 2011 sampling

- At the end of August 2011, 59 (92%) of the 64 EI participants over six years of age had detectable levels of 2,4-D in urine.
- Statistical tests on urinary 2,4-D levels indicated that the range of levels was consistent with the general population at the time of sampling. Statistical comparisons at the 75th percentile were marginally significant (p-value=0.06); this indicates that there may be slightly more EI participants than expected in the upper quartile of the expected range.
- Three drinking water samples, one surface water sample, and three soil samples had detectable levels of pesticides (see Table 5).
- The levels of pesticides measured in urine, drinking water, surface water, and soil samples in fall 2011 are not expected to cause harmful health effects.
- There are insufficient data to determine if there is a statistically significant correlation between environmental sampling results and urine sampling results.
- All but one of the participants with pesticides detected in their environmental samples reported occasional or regular home use of herbicides, including those containing glyphosate and 2,4-D.
- None of the participants (including those with pesticides detected in their environmental samples) reported pesticide use in the week prior to urine sample collection.
- None of the known commercial pesticide applications that occurred during the fall 2011 urine sample collection used 2,4-D or atrazine.
- Eight of the 13 known commercial, public, or private pesticide applications that occurred during the fall 2011 environmental sample collection used glyphosate, which was detected in two households' soil samples. However, the applications occurred over three miles away from these households.
- Some evidence suggests that under certain circumstances, pesticides may travel long distances; therefore, it is unclear whether 2,4-D and glyphosate detections in participants' soil samples can be linked to known commercial, public, or private pesticide applications.

Spring 2012 Sampling/Investigation Suspension

In the original investigation plan, urine and air samples were to be collected in spring 2012 to evaluate the only medium (ambient air) not tested in fall 2011. The spring 2012 data would have been used to determine if aerial pesticide applications resulted in measureable levels of pesticides in air and in the urine of residents in the investigation area. OHA and ATSDR planned to collect urine from local residents prior to and immediately following aerial applications of 2,4-D and/or atrazine. EPA and DEQ planned to collect air samples during application events and test these samples for a wider range of pesticides.

The EI team suspended spring sampling on March 8, 2012 because the areas that were slated for spring applications of 2,4-D and/or atrazine were targeted in remote locations that have very few residents. In spite of significant effort, OHA was unable to recruit enough participants for pre/post-application urine sampling. Further, EPA and DEQ were not ready to conduct air monitoring at the time. After suspending the investigation, the EI team reassessed progress on answering the investigation questions, and considered options to fill the remaining data gaps. OHA decided not to pursue additional biosampling because of the technical and logistical challenges involved in a pre/post-application sampling design. These challenges include the limited number of pesticides able to be measured in urine; lack of appropriate comparison data for most pesticides in urine; the relatively short half-lives of 2,4-D and atrazine in urine; and difficulty in obtaining information about the exact timing of planned pesticide applications. EPA is developing a sampling method to passively monitor air for pesticides of interest. However, it is unlikely that air monitoring will occur until late 2014.

Community-Collected Data

ATSDR allows for the inclusion of community-collected data in EIs and provides guidelines for evaluating the quality of these data [6]. According to ATSDR guidelines, data should be weighted based on impartial data quality criteria and not on the credentials or background of the entity that provided or collected the data [6].

In early spring 2012, while OHA was trying to recruit participants for the pre- and post-spray urine sampling, some community members indicated their willingness to share the community-collected urine sample data collected in spring 2011. They also offered to share environmental data (water and air) they had collected at their own expense in the investigation area. The community members requested the EI team evaluate their data for inclusion in the EI. The EI team agreed to evaluate community-collected urine and environmental data for chain of custody, quality control, and their potential implications for exposure and human health.

Community members and the private consultants and laboratories they employed supplied OHA, DEQ, and EPA with all the documentation needed to evaluate the quality of the community-collected data. OHA, DEQ, and EPA reviewed this documentation and agree that the data are of sufficient quality to be analyzed and presented in this PHA (with the exceptions noted in the sections below). Details of our data quality evaluation process are presented in the sections below.

Community-Collected Urine Data

Community members in the Highway 36 Corridor collected urine samples in spring 2011 as part of their own assessment, independent of government agency oversight. Community organizers recruited 43 individuals to participate and organized the collection of 62 urine samples from these participants between February 8 and June 1, 2011. A research professor at Emory University in Atlanta, Georgia tested the urine samples received by her laboratory for evidence of recent pesticide exposures.

In May and June 2012, OHA obtained written informed consent from 29 participants who live in the investigation area to use their spring 2011 urine results for this PHA. OHA obtained these 29 participants' results directly from the Emory University researcher.

Residents' decision to collect samples

OHA contacted the 29 consenting individuals in the investigation area to learn more about the sequence of events that occurred around the time of the spring 2011 urine collection. We asked them to describe what prompted them to collect urine samples at various times between February and June 2011. About half the participants collected samples in February 2011 with the intention of having their urine tested before aerial pesticide applications began for the spring season. Participants used ODF's Notification of Operation system to determine when the spring application season would begin. As one participant stated, "We didn't just assume that there had been no spray. We had no notifications, and it was very much the end of the "no-spray" season. There is a good network of people out here with notifications; nothing had been scheduled for months." Other participants provided their first samples in March and April 2011.

Beginning April 9, 2011, community members started collecting second urine samples in order to capture what they believed were "post-spray" conditions. Over the course of the spring 2011 spray season, ten of the 29 consenting participants collected a second sample that was ultimately used in the EI (See next section for details). The participants' reasons for collecting a second sample vary, but several participants reported collecting a second sample after:

- hearing, seeing, and/or filming an aerial spraying;
- receiving notification by email that a spray was occurring nearby; or
- feeling unwell or reportedly experiencing symptoms they attributed to nearby spraying.

One participant stated, "We were trying to figure out when to go for the 2nd test. But tracking sprays is impossible to do because there is too broad a scope of time between when you get notified and when they spray, so we just started getting sick one day at the same time, and went in to get tested after realizing we couldn't track it."

In May and June 2011, more participants began providing initial urine samples because they either witnessed an aerial spray or experienced symptoms they attributed to nearby spraying.

Community urine sample collection, shipment, and laboratory analysis[13]

The 29 consenting participants within the investigation area provided 46 samples for the community urine collection. OHA verified that all 46 samples (100%) had a complete chain of custody from the time the residents had their urine collected at a PeaceHealth facility in Eugene, Oregon to the time PeaceHealth shipped the samples to Emory University (Table 6). OHA confirmed that Emory's Central Shipping and Receiving (CS&R) facility received 33 of the 46 samples (72%), and that the researcher's laboratory received 26 samples (57%). OHA was unable to verify a receipt date for 13 samples at either Emory CS&R or the lab. OHA also found that seven samples received by the lab were apparently not

[13] See Appendix D for detailed information on residents' sample collection, shipment, and laboratory analysis.

tested. In all, the researcher analyzed 39 of the 46 samples for 2,4-D and atrazine metabolites and provided these results to OHA. These 39 samples still represented all 29 individual participants, ten of whom provided samples at two different times. Urine samples were kept frozen throughout transport and in storage until the time of analysis. The researcher used CDC method 6107.01 [38] to analyze urine samples for atrazine metabolites and CDC method 6103.01 [39]to test urine samples for 2,4-D. No field blanks were included with the community-collected samples.

Table 6: Chain of custody for 46 community-collected urine samples.

Number of Samples with Confirmed Collection Documentation at Peace Health	Number of Samples with Confirmed Transport Date by PeaceHealth Courier	Number of Samples with Confirmed Shipment Date from PeaceHealth to Emory	Number of Samples with Confirmed Receipt Date at Emory	Number of Samples with Confirmed Receipt Date at Lab	Number of Samples with 2,4-D/ Atrazine results from Lab
46	46	46	33	26	39
2,4-D = 2,4-dichlorophenoxy acetic acid					

OHA analysis of community-collected urine results

The researcher tested the 39 community-collected urine samples for 2,4-D and three metabolites of atrazine: diaminochlorotriazine (DACT), desethyl atrazine (DEA), and di-dealkylated atrazine mercapturate (DAAM). For ease of analysis and interpretation, we present atrazine results as atrazine equivalents. OHA was not able to adjust the urinary 2,4-D and atrazine results for creatinine because the 39 samples were not tested for creatinine. Results are presented as straight urine concentrations in micrograms per liter (μg/L). Table 7 shows basic descriptive statistics for the 39 community-collected samples.[14]

Table 7: Summary urine results (μg/L) from spring 2011 community-collected samples (N = 39).

Contaminant	Mean* (Range)	25^{th} Percentile	50^{th} Percentile	75^{th} Percentile	95^{th} Percentile
2,4-D	4.9 (0.7-31.7)	2.2	5.0	11.7	25.6
Atrazine equivalents†	5.0 (0.6-62.1)	2.4	4.8	11.4	29.8
*Mean is geometric mean; †Atrazine equivalents reflect the sum of measurements of the metabolites diaminochlorotriazine (DACT), desethyl atrazine (DEA), di-dealkylated-atrazine mercapturate (DAAM) 2,4-D = 2,4-dichlorophenoxy acetic acid					

All 39 samples had detectable levels of 2,4-D and atrazine metabolites. OHA compared the spring 2011 community-collected urine samples to the fall 2011 samples collected by ATSDR (Table 8) using a

[14]OHA used geometric means instead of arithmetic means in order to compare the EI data to NHANES data (which are reported as geometric means). Arithmetic means are calculated by adding up all the results and dividing the result by the number of results (n). Geometric mean is calculated by multiplying all the results and then taking nth root of the product.

statistical test called the Mann-Whitney U Test. For 2,4-D, the geometric mean in spring 2011 samples was significantly higher than the geometric mean in fall 2011 samples. Atrazine metabolites were found in all of the spring 2011 samples, while none were found in fall 2011 samples.

Table 8: Comparison of spring 2011 community-collected samples to fall 2011 ATSDR samples.

Contaminant	Spring 2011 Mean* (μg/L) (N=39)	Fall 2011 Mean* (μg/L) (N=64)	Mann-Whitney U Test (P Value)
2,4-D	4.9	0.37	<0.0001
Atrazine equivalents	5.0	None detected	-
*Geometric mean; μg/L = micrograms per liter; 2,4-D = 2,4-dichlorophenoxy acetic acid			

OHA determined that 20 of the 39 community-collected samples had the necessary documentation to establish a complete chain of custody from the time the samples were collected at PeaceHealth to the time they were delivered to Emory University. The missing documentation for the other 19 samples consisted of the slips confirming receipt at either Emory University's CS&R or the Emory laboratory. However, there was complete documentation confirming that the samples were shipped from PeaceHealth's shipping facility, and the Emory lab had results for these samples. This indicates that these 19 samples were actually delivered to the laboratory at Emory.

OHA conducted an additional statistical analysis to verify that these 19 samples were not statistically different from the rest of the samples. The average levels of 2,4-D and atrazine metabolites in the 19 samples without complete chain of custody were not statistically different from the average levels in the 20 samples with complete chain of custody (Table 9). Therefore, OHA accepted all 39 samples as valid test results, and all 39 were included in the analyses and conclusions presented.

Table 9: Comparison of urinary 2,4-D and atrazine levels by chain of custody, spring 2011.

Chemical	Incomplete custody sample mean* (N = 19)	Complete custody sample mean* (N = 20)	Wilcoxon two-sample P-value
2,4-D (μg/L)	6.2	3.9	0.1477
Atrazine Equivalents (μg/L)	6.6	3.8	0.1363
*Geometric mean; μg/L = micrograms per liter; N = number; 2,4-D = 2,4-dichlorophenoxy acetic acid			

Comparison to Application Record Data

After obtaining the community-collected urine data and the pesticide application records, OHA was able to identify the urine samples that were collected before and after known applications of 2,4-D and/or atrazine. Of the 39 community-collected samples, 13 were collected prior to any reported commercial applications of 2,4-D or atrazine. Of the remaining 26 samples, nine were collected within 24 hours of an application of 2,4-D or atrazine[15] and 17 were collected between 3 and 22 days after an application of 2,4-D or atrazine. The 24-hour time frame is significant because 2,4-D and atrazine are rapidly cleared from urine, so samples are most representative of exposures that occurred within the most recent 24-48 hours [31], [36], [37]. OHA reclassified the samples (independent from the classifications assigned by community members who provided the samples) as being either "pre-application" (N = 13) or "post-application" (N = 26). The subset of the post-application samples collected within 24 hours of a known application were classified as the "24-hour subset" (N = 9).

As previously mentioned, the 39 samples were provided by 29 participants; 10 participants provided two samples each. For each of these 10 participants, their first sample fell into the pre-application sample group, and their second sample fell into the post-application sample group. Therefore, no single participant had more than one sample in either the pre-application (N=13) or post-application (N = 26) sample groups.

For the ten participants with both pre- and post-application samples available, OHA was able to compare urinary 2,4-D and atrazine metabolite concentrations in pre- and post-application samples from the same participants (also known as a "matched pairs analysis"). This comparison was done using a statistical test called the Wilcoxon signed rank test. This test found no statistically significant difference between pre- and post-application urine samples for either 2,4-D ($p = 0.5$) or atrazine metabolites ($p = 0.11$). Out of the ten participants for whom OHA was able to compare pre- and post-application samples, seven collected their second sample within 24-hours of an application. Thus, these second samples were part of the 24-hour subset (N=9). The other three participants with available pre- and post-application samples collected their second samples 3-8 days after the most recent known pesticide application in the area. OHA did another matched pairs analysis of pre- and post-application samples including only those seven participants whose post-application sample was part of the 24-hour subset, using the same statistical test. This test also found no statistically significant difference between pre- and post-application urine samples for either 2,4-D ($p = 0.5$) or atrazine metabolites ($p = 0.3$).

OHA compared the average 2,4-D and atrazine metabolite concentrations of the 13 pre-application samples to the levels found in the 26 post-application samples (Table 10). There was no statistical difference between the two groups. This indicates a source of 2,4-D and atrazine exposure to participants that is not explained by any of the available application records.

[15] In 2011, there were 16 commercial pesticide applications that included the use of 2,4-D or atrazine. Thirteen of these applications occurred in April 2011 and three occurred in May 2011.

Table 10: Comparison of pre-application and post-application levels of 2,4-D and atrazine in urine, spring 2011.

Chemical	Pre-application sample mean* (N = 13)	Post application sample mean* (N = 26)	Exact Wilcoxon two-sample P-value
2,4-D (μg/L)	5.4	4.7	0.63
Atrazine Equivalent (μg/L)	5.3	4.8	0.72
*Geometric mean; μg/L = micrograms per liter; N = number; 2,4-D = 2,4-dichlorophenoxy acetic acid			

OHA also compared the average 2,4-D and atrazine metabolite concentrations of the nine 24-hour subset samples against those of the other 30 spring 2011 samples (Table 11). The levels of 2,4-D were statistically similar between the two groups. However, the levels of atrazine metabolites were significantly higher in the nine 24-hour subset samples.

Table 11. Comparison of urinary 2,4-D and atrazine metabolite levels between 24-hour subset and all other samples, in spring 2011.

Chemical	All samples not within 24 hours of application mean* (N = 30)	24-hour subset sample mean* (N = 9)	Exact Wilcoxon two-sample P-value
2,4-D (μg/L)	4.4	7.2	0.2312
Atrazine Equivalent (μg/L)	4.0	10.0	0.0450**
*Geometric mean; μg/L = micrograms per liter; N = number; 2,4-D = 2,4-dichlorophenoxy acetic acid ****Indicates a statistically significant finding ($p < 0.05$)**			

The higher levels of atrazine found in the 24-hour subset samples suggest that these samples were collected at a time when there were relatively higher levels of atrazine exposure among participating community members. Four known applications (three on one day and one on another) of atrazine were associated with the nine 24-hour subset samples. All four applications were aerial and co-applied with 2,4-D. These four applications were located between 2 and 3.8 miles from the homes of participants who provided these samples with the average distance being 2.65 miles.

There were no environmental monitoring data associated with these four applications, which could have provided confirmatory site-specific information about the movement of atrazine from the application site to participants' homes. There is evidence from other studies that suggest aerially applied pesticides in general [29], [30], [32]–[35], and atrazine in particular [31], can travel long distances from the application site. Therefore, it is possible that local aerial atrazine applications contributed, alone or in part, to the relatively elevated levels of urinary atrazine metabolites detected in the nine 24-hour subset samples. However, it is also possible that the apparent increase reflects concurrent fluctuations in unknown sources of atrazine exposure in the environment.

2,4-D

NHANES tracks 2,4-D nationwide but it does not track the atrazine metabolites measured in the community-collected urine samples. Therefore, we were only able to compare the spring 2011 urine results to NHANES data for 2,4-D results. All of the samples (N=39) had 2,4-D concentrations greater than the 2003-2004 NHANES 75th percentile (0.58 µg/L). Eighty-five percent (84.6%) of all spring 2011 samples (N = 39) had 2,4-D concentrations higher than the NHANES 95th percentile (1.63 µg/L). All of these differences were statistically significant (Table 12). This means that at the time the samples were collected, the 2,4-D levels in participants' urine were statistically higher than the levels found in the general U.S. population.

Table 12: Comparison of 2,4-D levels in community-collected urine samples (N = 39) to 2003-2004 NHANES* data.

	Values above NHANES 75^{th} percentile (0.58 µg/L)		One Sample Binomial Test	Values above NHANES 95^{th} percentile (1.63 µg/L)		One Sample Binomial Test
Samples	Number	Percent	Two-sided Exact p-value	Number	Percent	Two-sided Exact p-value
Total (N = 39)	39	100	<0.0001	33	84.6	0.025
µg/L = micrograms per liter; NHANES = National Health and Nutrition Examination Survey; N = number						

We also compared the community-collected spring 2011 urine results to published studies measuring urinary 2,4-D levels in pesticide applicators. The community-collected results were most similar to two studies of 2,4-D exposures among farm applicators [40], [41] that found average pre-application 2,4-D levels of 7.8 and 3.8 µg/L, respectively.

To assess the potential health risks from the levels of exposure seen in community-collected urine samples, we compared the spring 2011 urine results to the biomonitoring equivalent (BE)[16] for 2,4-D. The BE was six times higher than the highest urinary 2,4-D concentration measured in spring 2011 samples (31.7 µg/L). OHA does not expect that the levels of 2,4-D exposures seen among participants in the spring 2011 urine assessment were high enough to pose risks to public health. Current scientific evidence indicates that none of the 2,4-D levels measured in Highway 36 Corridor residents in spring and fall 2011 indicate exposures that are expected to cause adverse health effects.

Atrazine

In the case of atrazine, there are no national reference values against which to compare the spring 2011 urine results. Therefore, OHA searched peer-reviewed literature for smaller studies where the same atrazine metabolites were measured in human urine. Table 13 summarizes these studies. The levels of atrazine metabolites measured in spring 2011 urine samples were in the higher range of those found in pregnant women in France [42], lower than those found in turf applicators, and in the range of those measured in non-occupationally exposed individuals [43]. In fall 2011, no atrazine or atrazine metabolites were detected in any of the participants, indicating that atrazine exposures were higher in spring than in fall.

[16] See Fall 2011 Urine results for additional information on the 2,4-D biomonitoring equivalent.

Table 13: Atrazine metabolite equivalents measured in peer reviewed literature.

Study	Population	Median atrazine equivalents (µg/L)	Metabolites measured	Range (µg/L)
French women's study [42]	Pregnant women in Brittany region of France (N = 579)	1.2[±]	DEA, DACT, DIA, atrazine mercapturate	ND – 17.1
Barr study [43]	Individuals with occupational* exposures (N = 8)	Not reported	DEA, DIA, DACT, DAAM, ATZ, ATZ-OH, DEA-OH	100-510
	Individuals with non-occupational exposures (N = 5)	Not reported		10-235

µg/L = micrograms per liter, DEA = Desethyl atrazine, DIA = desisopropyl atrazine, DACT = Diaminochlorotriazine, DAAM = Didealkylated atrazine mercapturate, ATZ = atrazine, ATZ-OH = hydroxy atrazine, DEA-OH = hydroxy desethyl atrazine, N = number, ND = non-detect
± Median among detected values; *Commercial lawn care applicators

Unlike 2,4-D, there are no published BEs for atrazine metabolites, so it is not possible to compare these results against toxicity-based threshold values. Therefore, it is not possible at this time to determine if the levels of atrazine metabolites found in the spring 2011 urine samples could be associated with adverse health effects.

Uncertainties/Limitations

- The spring 2011 community urine samples were collected as part of an independent assessment. Aside from the application records provided by regulated pesticide applicators in the area, we do not have information on other potential sources of exposure that could explain the higher than expected levels of 2,4-D and atrazine metabolites found in these participants' urine samples.
- Contaminant levels in urine are influenced by the hydration status and kidney function of the person who provided the sample. In many studies, these factors are controlled by measuring the amount of creatinine (a urinary by-product of protein metabolism that is filtered by the kidney at a known and predictable rate) and relating contaminant levels to the amount of creatinine. Urinary creatinine levels can vary greatly from person to person, depending on the individual's age, sex, body mass, and other factors [22]. Because the spring 2011 urine samples were not tested for creatinine, we were not able to control for the variables of hydration status or kidney function in our analyses.

Summary of community-collected urine data

- All 39 samples from 29 participants in the community urine collection had detectable levels of 2,4-D and atrazine metabolites.
- The levels of 2,4-D measured in the urine of 39 Highway 36 Corridor residents in spring 2011 were statistically higher than those found in the general U.S. population and statistically higher than the levels measured in Highway 36 Corridor residents in fall 2011. The levels of atrazine metabolites measured in spring 2011 were higher than the levels found in fall 2011.
- Higher than expected 2,4-D and atrazine metabolite levels in urine samples collected both before and after the start of known pesticide applications in the area indicate that there is an unknown

source of these pesticides that is not accounted for in the application records available to OHA. It is possible that these results were influenced by environmental conditions, which fluctuate seasonally.

- The urinary levels of 2,4-D measured in spring 2011 were several times lower than the BE for 2,4-D (200 μg/L), and do not indicate a public health risk.
- We cannot determine if the levels of atrazine metabolites measured in spring 2011 pose health risks because there is no toxicity-based threshold for atrazine concentrations in urine.
- The levels of atrazine metabolites in community-collected urine samples were significantly higher in samples collected within a day of a known application of atrazine compared to samples that were not collected within a day of a known application. While the local applications of 2,4-D and atrazine may have contributed, in full or in part, to these increased concentrations, there is no concurrent environmental sampling data on atrazine's persistence or distance traveled from the application site to confirm that this is the case. There is conflicting evidence regarding whether the distance of two miles from the point of application to the participants' homes is sufficiently protective; in addition, we do not know if there were concurrent fluctuations in the unknown sources of atrazine exposure in the environment.

Community-Collected Environmental Data

Water (POCIS) Data

Some members of the community, called the Siuslaw Watershed Guardians (SWG), conducted surface water sampling within the investigation area, in the spring and summer months of 2011, independently and at their own expense. This section describes their work and results.

Methods

The SWG used Polar Organic Chemical Integrative Samplers (POCIS), which are designed to absorb organic chemicals that have dissolved in water. POCIS samplers are typically positioned in a stream and left for up to 28 days. Because of the long deployment time and continuous sampling, POCIS allows for measurement of very low concentrations of chemicals, in fact much lower than could be detected using traditional water sampling methods. However, results from POCIS samplers cannot be used to evaluate human exposure. This is because it is impossible to obtain the two pieces of information needed to calculate the concentration of a contaminant in water: the volume of water sampled by the POCIS (i.e. liters per day) and the associated uptake rate of the chemical (i.e., micrograms or milligrams of a contaminant). Therefore, POCIS results are mainly qualitative in nature and are reported as an amount of chemical per individual POCIS sampler (e.g., nanograms per POCIS or ng/POCIS) [44]. In other words, we can describe the presence and amount of a chemical found in the POCIS sampler, but not the exact concentration in the water. POCIS data are often used to compare relative amounts of contaminants at one time or location with another time or similar location. For example, POCIS data can be used to compare contaminant levels in two tributaries or to monitor seasonal variations in contaminant levels in a particular stream.

The SWG deployed POCIS samplers at five locations shown in Table 14. Most samplers were deployed from April to May of 2011, but one was deployed from June to July of 2011. Duplicate samples were collected at two sample locations: Fish Creek (near the mouth) and Nelson Creek (downstream from

Almaisie Creek). The SWG POCIS samplers were analyzed by Anatek labs in Moscow, Idaho for seven analytes: 2,4-D, atrazine, desethyl atrazine, desisopropyl atrazine, hexazinone, trichloropyridinol, and triclopyr. Desethyl atrazine and desisopropyl atrazine are breakdown products of atrazine.

With the permission of the community, Anatek Labs sent data and data quality assurance/control reports to DEQ for independent review. DEQ reviewed the raw lab data and Anatek' s quality assurance/control procedures. DEQ also compared the SWG sampling results to POCIS data collected by DEQ in other parts of the state. DEQ found that the SWG used valid sampling methods and that the analysis performed by Anatek Labs was appropriate and valid for the purposes of the study. DEQ provided OHA with a summary of their findings.

Results

The SWG POCIS samples contained atrazine, hexazinone, and desethyl atrazine (Table 14). Two of these contaminants, atrazine and hexazinone, are typically found by DEQ in waters throughout the state. However, streams where DEQ tends to find atrazine and hexazinone are larger than the ones tested by the SWG and tend to drain lands with more uses, including agriculture. The only documented pesticide applications upstream of the POCIS samplers were forestry related. Desethyl atrazine is not measured in DEQ's statewide Toxics Monitoring Program; therefore, we do not know if the presence of this chemical in SWG's samplers is unusual. DEQ frequently detects 2,4-D and triclopyr as part of its statewide POCIS monitoring, but neither of these chemicals were detected in the SWG samplers. Because these POCIS sampling results cannot be expressed as concentrations in water, OHA was not able to further evaluate these data by comparing them to health-based CVs for contaminants in water.

Uncertainties

There was no information about stream flow rate provided, and this creates some uncertainty in comparing results from one stream or location with another.

Table 14: Community POCIS data for surface water.

			Analytes (ng/POCIS)						
Sample Location	Deployment Dates	Lab Analysis Date	2,4-D	Atrazine	Desethyl Atrazine	Desisopropyl Atrazine	Hexazinone	Trichloropyridinol	Triclopyr
Fish Creek Near Mouth	4/17/2011-5/15/2011	9/8/2011	ND	52.3	15.9	ND	64	ND	ND
Fish Creek Near Mouth (Duplicate)	4/17/2011 - 5/15/2011	5/15/2012	NR	93	26.7	NR	81	NR	NR
Lake Creek Upstream of Fish Creek	4/17/2011 - 5/15/2011	9/8/2011	ND	15.8	0.9	ND	9.3	ND	ND
Congdon Creek a quarter mile from mouth	4/23/2011 - 5/21/2011	9/8/2011	ND	1.9	ND	ND	3.6	ND	ND
Unnamed drainage to Congdon Creek	4/23/2011-5/21/2011	9/8/2011	ND	ND	ND	ND	ND	ND	ND
Nelson Creek downstream of Almaisie Creek	6/3/2011 - 7/3/2011	9/8/2011	ND	ND	ND	ND	13.6	ND	ND
Nelson Creek downstream of Almaisie Creek (duplicate)	6/3/2011-7/3/2011	5/15/2012	NR	ND	ND	NR	16.8	NR	NR
ng = nanograms; POCIS = Polar Organic Chemical Integrative Samplers; ND = Not detected; NR= Not reported; 2,4-D = 2,4-dichlorophenoxy acetic acid									

Air Data

Highway 36 community members also conducted air sampling within the investigation area and submitted the results to OHA for review and inclusion in this PHA (Table 15).

Methods

Community members provided data on 16 air samples in the investigation area. Eleven samples were collected in October 2011, one sample was collected in March 2012, and four samples were collected in May 2012. Community members collected samples around Fish Creek, Triangle Lake, and private residences in the valleys below private timberlands. The 11 October samples and one March sample were intended as baseline data, meaning that no known pesticide applications were occurring when the samples were collected. The May 2012 samples were collected during and immediately following a pesticide application on nearby forestland.

Samples were collected using Tisch Environmental, Inc. Te-PUF Polyurethane foam high volume active air samplers according to the manufacturer's instructions.[17] Field blanks accompanied and were analyzed along with each of the samples. Each sample was collected over approximately 12 hours resulting in total collected air volumes ranging from 77 – 147 m^3. The samples were sent directly to Anatek Labs in Moscow, Idaho for analysis. Anatek labs analyzed each sample for 27 chemicals: clopyralid; 2,4,5-trichlorophenoxyacetic acid (2,4,5-T); 2-(2,4,5-Trichlorophenoxy)propionic acid (2,4,5-TP or Silvex); 2,4-dichlorophenoxy acetic acid (2,4-D); 4-(2,4-dichlorophenoxy)butyric acid (2,4-DB); dacthal; dalapon; dicamba; dichloroprop; dinoseb; 2-methyl-4-chlorophenoxyacetic acid (MCPA); picloram; atrazine; chlorsulfuron; desethyl atrazine; halosulfuron; hexazinone; imazapyr; imazosulfuron; iodosulfuron; metsulfuron methyl; nicosulfuron; prosulfuron; rimsulfuron; sulfometuron methyl; triasulfuron; and tiflusulfuron methyl.

Results

Most of the air samples were non-detect for all 27 chemicals tested. Six of the 11 samples collected in October tested positive for 2,4-D. The field blanks associated with four of these six samples also tested positive and contained similar amounts of 2,4-D. This indicates that these four samples were likely contaminated and must be classified as non-detects. One of these field blanks also tested positive for picloram, but picloram was not detected in the main sample. Because of these contamination issues, OHA and DEQ do not consider the October air sample results to be valid.

One of the four samples collected in May, which was collected during an observed pesticide application to nearby forestland, had a positive detection of clopyralid at 0.37 ng/m^3. This appears to be a valid result, as the field blank was clean. OHA does not currently have access to the pesticide application records that correlate to the observed application. However, clopyralid was one of the pesticides listed on the notification record associated with that harvest unit.

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[17] This type of active sampling is different from the passive air sampling methods that EPA is working to develop. Active sampling requires a power source and tight coordination with pesticide applicators to know exactly when to start the 12-hour sample collection window. Passive sampling would not require a power source or this type of coordination.

There is no established health-based screening level for clopyralid in air. However, there is a standard method for converting an oral reference dose (RfD) into a reference concentration (RfC) [45]. An RfC is an estimate of a continuous inhalation exposure concentration that is likely to be without risk of harmful effects during a lifetime of exposure. An RfC builds in safety margins that are intended to be protective of the most sensitive populations.

Appling this method to clopyralid's RfD (150 μg/kg-day) [46] yields an RfC of 525,000 ng/m^3. The level of clopyralid measured in the community-collected air sample (0.37 ng/m^3) is over a million times lower than the calculated RfC. This indicates that the level of clopyralid measured at this time and location is unlikely to pose a public health risk.

Table 15: Community-collected air data – valid detections.

Collection Date	Detections /Valid Samples	Analytes Detected	Maximum Analyte Concentration Detected (ng/m^3)	Health-based Screening Value (ng/m^3)	Source of screening value
May 2012	1/4	Clopyralid	0.37	525,000	Derived RfC*

ng/m^3 = nanograms per cubic meter; 2,4-D = 2,4-dichlorophenoxy acetic acid; RfC = Reference Concentration
*Derived from the U.S. Environmental Protection Agency's oral reference dose for clopyralid

Uncertainties

- Each of these samples was collected over an approximate 12-hour time period, and the results represent a snapshot in time. Therefore, it is unknown whether the results are typical for the locations or times sampled.
- The derived RfC for clopyralid is based on chronic or long-term exposure. It is not ideal to compare a 12-hour sample to a chronic RfC. However, no short-term or acute inhalation toxicity values for clopyralid are currently available. In general, short-term and acute toxicity values are higher than chronic toxicity values. Therefore, comparing a short-term sampling result to a chronic RfC is a conservative approach that is protective of health.
- The method for extrapolating an RfC from an oral RfD is not as precise or as valid as an RfC derived from actual inhalation toxicology studies. Some chemicals have different toxicities and endpoints depending on the route of exposure (i.e., inhalation vs. ingestion). The calculated RfC does not account for inhalation-specific toxic effects. Chemicals may come into contact with different organs when inhaled as opposed to ingested. This can lead to differential toxicity based on the sensitivity of the organ that comes into contact with the chemical. Therefore, this calculated RfC might be more or less protective than a traditionally derived RfC. However, clopyralid would have to be over a million times more toxic via the inhalation route than the ingestion route for the measured concentration to pose a public health risk. While many chemicals are more toxic via the inhalation pathway than the ingestion pathway, it is unusual for the difference in toxicity to be as great as a million fold.

Evaluation of Health Outcome Data

ATSDR requires its cooperative agreement partners to consider if health outcome (i.e., mortality and morbidity) data (HOD) should be evaluated in a PHA [6]. The main requirements for evaluating HOD are: the presence of a completed human exposure pathway; a known time period of exposure; a quantified population that was (or is being) exposed; sufficient contaminant levels and time to result in health effects; and the availability of systematically collected HOD for the health outcomes associated with chemicals in the pathway [6].

The Highway 36 Corridor investigation does not meet the requirements for including an evaluation of HOD as part of this assessment.. There are two main reasons we did not evaluate HOD. First, we do not know how many people have been (or are being) exposed to pesticides in the Highway 36 investigation area. Second, there has been no systematic measurement HODs related to pesticide exposure. Further:

- The environmental data collected in fall 2011 indicate that people were not being exposed to pesticides in drinking water, soil, or homegrown foods at levels that could harm human health.
- The levels of 2,4-D measured in community members' urine in spring and fall 2011 were below levels of health concern.
- For community residents who had atrazine detected in their urine in spring 2011, we do not know if they were exposed at levels that could result in health effects and if enough time has passed for these health effects to develop. We also do not know which effects to look for because there is limited scientific evidence on the health effects associated with atrazine exposure. Atrazine is a known endocrine disrupter that has been associated with hormonal and reproductive effects in animals and humans. However, there is currently not enough evidence to identify the specific effects associated with low-level exposures to atrazine in humans (See Appendix F).

Children's Health Considerations

OHA and ATSDR recognize that infants and children may be more vulnerable to exposures than adults in communities faced with contamination of their air, water, soil, or food. This vulnerability is a result of the following factors:

- Children are more likely to play outdoors and bring food into contaminated areas.
- Children are shorter, resulting in a greater likelihood to breathe dust, soil, and heavy vapors close to the ground.
- Children are smaller, resulting in higher doses of chemical exposure per body weight.
- The developing body systems of children can sustain permanent damage if toxic exposures occur during critical growth stages.
- Children are more likely to swallow or drink water during bathing or when playing in and around water.
- Children are more prone to mouthing objects and eating non-food items like toys and soil.

Because children depend on adults for risk identification and management decisions, ATSDR is committed to evaluating their special interests in the Highway 36 Corridor. In this PHA, children were identified as the most vulnerable to health problems caused by pesticides. OHA has designed conclusions and recommendations that, if followed, will protect children from these potentially dangerous chemical exposures.

Community Concerns

This section of the report describes Highway 36 community concerns related to forestland and agricultural pesticide applications, chemical exposures, and the EI. Understanding community health concerns related to a site or environmental contamination is an important component of the public health assessment process and ATSDR's overall mission. It is important to gather this information early and continuously through the investigation process [6]. ATSDR embraces the philosophy that community involvement requires earnest, respectful, and continued attention. Furthermore, ATSDR believes that one of the keys to the success of the public health assessment process lies in the ability to establish clear expectations, communicate effectively, and place the community at the center of its response [6]. A community's perspective provides a vital link to science by ensuring that our work is relevant.

The term "community" as used in this section of the report includes individuals who reside in the investigation area. However, because of the dynamic nature of social interactions individuals may belong to multiple communities at any one time. A person may be a member of a community by choice or by virtue of their innate personal characteristics, such as age, gender, race, or ethnicity [47]. Therefore, when initiating community engagement efforts, we make every effort to be aware of these complex associations [48], and be inclusive of all individuals who identify as being a member of a given community. This inclusiveness is important for understanding prevailing attitudes, beliefs, actions, and concerns that help to inform and improve our work.

For this section of the report, OHA evaluated qualitative data from several sources. In environmental public health, qualitative information helps public health practitioners understand the daily lives of people in the community in order to:

- learn about a community's history;
- focus on community priorities;
- understand how to best respond to community concerns;
- determine how people may be exposed to potential environmental contamination;
- identify the most effective ways to reduce potential exposures;
- communicate in relevant, inclusive, and equitable ways; and
- ensure the diversity of a community's perspective is represented [49].

Table 16 describes the sources of qualitative data we evaluated in this report. Because of the dynamic nature of social interactions and the lengthy history of both industrial chemical use and anti-pesticide activism in this area of the coastal mountains, we have included relevant information that may extend beyond the eight township-ranges that encompass the investigation area.

The community concerns section is not a sociological study, nor does it substitute for the report's conclusions. The purposes of this section are to:

- convey what we have learned is important to the community,

- understand the best ways to provide balanced and objective information, and
- assist with understanding the problems, alternatives, opportunities, and/or solutions.

OHA values, documents, and responds to community input as part of its public health assessment process. Listing or documenting a concern does not mean that we are verifying it as a fact, nor does it indicate our intent to address it with a specific recommendation. We also recognize that the information presented here is not an exhaustive list of concerns. Community members and the public will have an opportunity to review and comment on this section during the public comment period in order to ensure accurate representation.

Table 16: Qualitative data used in this Exposure Investigation.

Qualitative data sources	Types of data included	Usefulness
Participation	Meetings - internal & external, providing assistance, engaging in outreach, encouraging feedback, developing involvement approaches	Establishes relationships, builds rapport & promotes transparency with community; enhances ability to represent community's perspective in the investigation; uncovers assumptions
Observation	Visits and interactions with community, field notes, reflections, community meetings, filmed events, social media	Discovers the multiple communities within the investigation area & the complex set of community dynamics
Interviews, correspondences & conversations	Phone calls, visits to individual homes, conversations at community meetings, emails, correspondences and letters	Uncovers and describes community members' perspectives on events
Review of Documents	News stories, blogs, journal articles, agency documents, reports, community gathered qualitative data, editorials, speeches, pamphlets, newsletters, books, announcements	Documents experiences, values and beliefs of the community; useful in understanding and describing community dynamics; places EI into geographic and historical context
Videos, films & photographs	Community-submitted video, documentaries and photographs; YouTube videos documenting community meetings and gatherings; social media	Discovery; validation of community's experiences; provides information from non-replicable, unique events
Historical analysis	Oral testimonies, life histories, historical records, past events, contemporary records, legal records, statutes, public reports, advocacy group work, demonstrations, reports of eyewitnesses	Discovery; establishes a context for and enhances credibility of community concerns; re-examines questions & assumptions

Qualitative data sources	Types of data included	Usefulness
Questionnaires & surveys	Recruitment and pesticide use questionnaires, urine sample collection surveys	Provides direct answers to specific questions about community knowledge, actions, food sources, activities, time spent outdoors, occupation & hobbies

Analysis of qualitative data

OHA staff reviewed substantial amounts of information in the form of comments, questions, emails, phone calls, historical and legal documents, media articles, videotaped events, observations during public meetings, and other qualitative information sources. OHA grouped this information into four major categories, or themes, based on content analysis. These four themes are:

1. Past and current exposures to pesticides from local pesticide applications
2. Health concerns reported by community members that they attribute to local pesticide applications
3. Psychological, emotional, and social stress
4. Inadequate protection of public health

The following sections describe each of these themes in more detail.

1. Past and current exposures to pesticides from local pesticide applications

Community groups living in and around Oregon's coastal mountain range have raised concerns about the chemicals used in forestland management for several decades. While this EI is focused on chemicals used in both forest and agricultural practices, the predominant community concerns raised throughout the years by members of the community relate to the aerial spraying of pesticides. Historical and legal documents dating back to the 1960s have documented aerial applications of chemicals, including dioxin-contaminated 2,4,5-Trichlorophenoxyacetic acid (2,4,5-T) [50], on forestlands, pastures, and rights-of-way in the coastal mountains. In 1979, EPA issued an emergency order suspending the use of 2,4,5-T and Silvex after documenting high miscarriage rates among women living near Alsea in Oregon's coastal mountain range [51]. Some people who currently live in the investigation area were involved in these early efforts to stop aerial pesticide applications and continue to document their experiences. Some residents report being unaware of local pesticide application practices before moving into the area.

The investigation team heard many community members' concerns about their personal health, the health of their children, and the health of their animals and the environment. Some of these residents moved to the area intending to live and farm organically. They express frustration and anger about their inability to take action to protect their families and farms from alleged chemical drift. They also are angry that any amount of chemicals used in forestry practices were found in their urine. Some community members report moving to the area to retire, but have either left or are considering the option of moving away to avoid the seasonal sprays, which they find intolerable. Some parents are upset and angry that the pesticide imazapyr was detected in the local school's drinking well water after the land above the school was clear-cut and treated with pesticides, which included imazapyr. Families in the investigation area have reported postponing having children and others worry their children will suffer from future health effects.

There are residents who have spent a great deal of time and money in an effort to understand the area's unique geographic conditions and cool moist climate. These residents have surmised that pesticides applied to the steep slopes of the mountains are drifting down into the valleys where they live. They believe pesticide drift is threatening crops grown by farms and vineyards in the area. They assert that the area's climate, which is conducive to fog formation, causes pesticides to "re-volatilize" (or vaporize repeatedly from the soil to air). They contend that the re-volatilized chemicals travel down from the application sites to the valleys where most of the residents live.

While we have heard and documented these concerns, it is important to note that other community members report having no health concerns related to local pesticide application practices. These residents claim they have not experienced health effects from pesticide applications in spite of having lived and worked in the area for generations. Some residents report that they have never missed a day of work due to illness. Many of these community members are timber owners, farmers, and ranchers who use traditional methods of weed control, including the use of pesticides. One resident explained that if an aerial application were planned for an adjoining property, they would sometimes ask the applicator to fly over their property and spray a segment of their land.

This group of residents wants to continue having pesticides available as tools to control noxious, invasive, and unwanted vegetation. They see this controversy as a private-property rights issue. Many of these community members have stated they view anti-pesticide efforts as an invasion of their personal rights to manage their own land. Some of these residents have reported feeling harassed and intimidated by neighbors who are opposed to the use of chemicals. They are worried about possible legal action if they use chemicals on their own farms and timberlands, and have modified their land use decisions in response to these fears. These community members have said they hope the EI will lay the issue to rest, and are worried about ongoing conflicts with their neighbors and within their community.

The third and potentially largest segment of the community does not identify with either of the two positions taken by their fellow community members. Nonetheless, they are affected by the conflict generated by these opposing views. They have said they are interested in the findings of the EI and express support for efforts to learn if exposures may be occurring from local application practices. They also express concern about the ongoing conflict within their community.

2. Health concerns reported by community members that they attribute to local pesticide applications

Some area residents have reported and documented their own health issues and those of their friends, families, and neighbors. They assert that their illnesses and conditions correspond with the seasonal pesticide applications. In the absence of systematically collected health outcome data (i.e., from disease registries) these residents have reconstructed events on their own and have concluded that there are an unusual number of health problems in this area. The health issues reported by these residents include miscarriage, birth defects, congenital disorders in children, and rare cancers in teenagers and young adults.

Pesticide-related health conditions are difficult to diagnose because many of the known symptoms cannot be distinguished from other common illnesses. Most doctors are not trained to identify these conditions. It is very difficult to link environmental exposures of any kind to a specific health outcome in an individual, especially when there is a great deal of uncertainty about the nature of the exposure. In the Highway 36 community, there are uncertainties about whether and how people are being exposed to pesticides from local application practices, and the extent of any exposures. There also are uncertainties about the multiple chemicals used in pesticide applications and their singular and combined health effects, especially on developing babies, children, and the reproductive system.

Below is a list of human health effects attributed by community members to seasonal pesticide applications:

- miscarriages
- birth defects
- stillborn babies
- infertility
- endocrine disorders
- abnormal menstruation
- rare cancers in teenagers and young adults
- other more common types of cancer
- rashes, sores and other skin ailments
- cysts
- cardiovascular effects: tightness in the chest, difficulty breathing, heart arrhythmia, heart attacks, stroke
- weakness, muscle cramps and spasms, joint pain
- moodiness, depression, anxiety, fear, stress and aggression
- PTSD (Post-Traumatic Stress Disorder) and ongoing traumatic stress disorders
- Parkinson's Disease
- burning/itchy/sore/dry eyes, nose and throat
- inability to concentrate, loss of memory, headaches
- Attention Deficit Disorder
- asthma, coughs
- stomach and intestinal ailments, nausea
- porphyria
- chemical sensitivity
- auto immune disorders
- hair loss
- kidney Failure

There are other people living in the investigation area who have not had any health problems associated with forest pesticide applications. They express confusion and skepticism about why others in the community report being sick and unwell. While several of these people express concern about the reports of illness, they also express concern that these reports may be blown out of proportion.

3. Psychological, emotional & social stress

Psychological stress and its associated health effects are well-documented in communities living with real or perceived chemical contamination [52]. People who are unwillingly exposed to chemicals often experience anger, fear, irritability, uncertainty, and worry over the possible health effects of their exposures. People in these situations report feeling helpless and less secure within their homes and communities. Over time, this stress can lead to major depression, chronic anxiety, or post-traumatic stress disorder (PTSD), and physical changes such as increased blood pressure, increased heart rate, and changes in stress hormones [52].

It is not uncommon for conflict to arise within communities where reports of environmental exposures are under investigation. The divisions described above that are occurring within the Highway 36 community mirror conflicts identified in other such communities. These conflicts indicate a breakdown in social cohesion, which is an important protective factor and source of support for individual and community health.

Residents in the Highway 36 area have documented or reported many of the symptoms associated with psychological stress. Residents have stated in public meetings and to agency staff that they are experiencing hostility, fear, and a loss of community cohesion. Residents describe a pervasive climate of suspicion about the intentions of fellow community members, government agencies and industry. During the course of the EI, several themes related to stress have emerged, including:

- Fear and anxiety about:
    - their health and the health of their children
    - possible contamination of their property and the health of their animals and wildlife
    - their personal safety, including intimidating gestures, outbursts, and threats of violence
- Frustration and anger
- Feelings of mistrust
- Alienation from neighbors or former acquaintances and the erosion of social support

The following sections describe these themes in more detail.

Fear and anxiety:

Much of the fear and anxiety expressed by some community residents is related to the still-evolving scientific understanding of the effects from low-dose chronic exposures to pesticides and the uncertainties about the long-term health consequences. Some express deeply held beliefs that any amount of contamination is unacceptable. These community members are concerned that chemicals used in the investigation area are endocrine disruptors, for which there is a great deal of scientific uncertainty.

In the face of these uncertainties, some community members draw upon their own knowledge, beliefs, and values to develop a personal interpretation of their overall risk, and seek out others whose interpretations are similar to their own [53]. Several advocacy groups have emerged within the Highway 36 community that represent opposing viewpoints on the use of chemicals, in particular the aerial spraying of chemicals. This has become a polarizing issue. The differing beliefs and interpretations about risk and exposure reflect, and may contribute to, social conflict within the community.

There are also concerns that some of these groups receive assistance and resources from organizations outside of the investigation area. This perceived interference by outside interests has amplified community divisions. All of these dynamics contribute to the overall levels of stress within the community, and make it more difficult for people to cope with real or perceived chemical contamination [54].

The investigation team has heard repeated claims that it is a person's "right to know" where and when applications will occur near their homes, and what chemicals have been or will actually be used. Community members have reported more stress and anxiety during spray seasons because they cannot get this information prior to actual pesticide applications. They seek this information so they can leave the area when applications occur and avoid potential exposure. At the same time, they express frustration that they must take these actions to protect themselves.

Several community members pay a fee of $25 a year to receive ODF's application notifications as a way to anticipate where and when applications will occur.[18] Community members have voiced their frustration with this notification system, and have reported the following issues to the investigation team:

- The fee is a hardship.
- Notifications are not available electronically.
- The period within which applications may occur is not specific (applications can occur between 15 days to 12 months after the notification is submitted).
- The chemicals listed include what could potentially be used, not what will actually be used.
- Handwritten notifications are sometimes illegible.
- Notifications are difficult to understand.
- The forms are not standardized, and they do not collect the same information from every applicator.
- Many of the notification forms are not fully filled out.
- Several notifications are sent at one time in a packet through the mail for a five-section or square mile area.
- Notifications include a topographical map without context for the larger geographic area.
- Subscribers are not given notice when their subscription is up for renewal.
- Once a subscription has lapsed, there is no way to obtain notifications for the lapsed period of time.
- There is no way to notify subscribers of modifications or changes to a particular notification once it has been sent to the subscriber.
- If a landowner requests a waiver for any notification requirements, subscribers are not informed about why the waiver was requested or if one was granted.

Personal Safety:
There is a history of mistrust and community conflict in the coastal mountain range. This conflict stems from divergent views on forest practices, property and human rights, land use and the environment, and differences in personal beliefs and lifestyles. This history is relevant because some community members who oppose the use of pesticides have expressed fear of retribution based on historical events. Some of this ongoing fear for personal safety originates from events that occurred in the 1970's that they witnessed or heard about from others. Historical and legal documents have described harassment of anti-pesticide activists by government agencies and industry. These include allegations of "suspicious house fires, cars that were rigged to explode" [55], and in one case involving a noted activist, being "harassed by aircraft flying dangerously low and, in the case of the helicopters, hovering and circling for extended periods of time" [56].

[18] Under ORS 527.670(8), ODF provides copies of notifications and written plans for designated areas to interested persons who pay the required fee. In addition, under ORS 527.670(6), ODF provides such information on a non-fee basis to persons with downstream surface water rights, if such persons request that service in writing.

Other residents report feeling intimidated by the approaches used by activists who are opposed to pesticide use. Some people have expressed fear that they will be sued or harassed for using chemicals on their property. Helicopter pilots and activists alike have reported or documented threats to their personal safety. The EI team has observed aggressive and intimidating gestures and language from both sides during public meetings or on recorded tapes and videos.

Frustration and Anger:

Residents express anger at many things, including: Oregon's Right to Farm and Forest Law; the Forest Practices Act (FPA); the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA); timber companies; pesticide makers; the chemical industry; trade lobbying organizations; environmental organizations; ODA; ODF; PARC; and the EI.

Community members have expressed frustration over having to navigate a complex system of governmental oversight in order to understand how to effect change. Some believe the law favors the economic interests of large industrial landowners more than it protects people's health. Other residents are frustrated and angry about letters they received from lawyers who were hired to prevent them from using chemicals on their own property. There are disputes and litigation between neighbors over allegations of chemical drift, economic and business losses, and property devaluation.

Mistrust and alienation:

Many community members have expressed some degree of mistrust and skepticism about industry's influence on the regulation of pesticides and on the EI. Some specific concerns related to the regulation of pesticides include:

- the chemical and timber industries' degree of influence over public policy relating to the regulation, application, and use of pesticides;
- the government's process for determining whether risks to human health are adequately understood and used to inform pesticide use laws; and
- the validity of research used to support claims of chemical safety and inform requirements for pesticide labeling and use.

Community members have also expressed skepticism about the EI, including concerns about the following:

- The EI lacks independence and scientific rigor. Community members are concerned that the EI will be unduly influenced by community activists who are intent on eliminating access to pesticides or by trade lobbying groups who are intent on ensuring continued access to the use of pesticides.
- The EI is an unwarranted expenditure of public funds.
- The resources needed to complete the investigation will be reduced or eliminated, or that industrial landowners have, and will continue, to thwart the investigation by using chemicals that cannot be tested for in urine.
- The EI is not inclusive enough of community input, does not allow community as an equal stakeholder, and is not doing enough to stop the spraying until the extent of human exposure is known.

4. Inadequate protection of public health

As pointed out, there is a wide range of viewpoints regarding aerial spraying and the use of pesticides within the Highway 36 community. Some people are confident that EPA's pesticide labeling and risk assessment process is protective of health. Others are skeptical and want the government to do more to protect their health. Some community members have proposed establishing aerial spray buffer zones around homes and schools, while others want a complete moratorium on all uses of pesticides.

Most community members express some degree of appreciation for the agencies' investment in their community and support for the investigation efforts. Some of these community members are comfortable with the initial, baseline EI conducted by ATSDR, are not concerned about exposures and question why the investigation continues. Others are frustrated with what they see as a delay in acting to prevent exposures they believe are occurring during each spray season.

Residents seeking a change in application practices express one or more of the following concerns or positions:

- Government agencies are not doing enough to protect private citizens' health.
- Existing environmental regulations are based on a risk assessment process that does not adequately protect human health and the environment.
- As science advances, pesticides will be found to be more harmful than previously thought.
- Government is not taking community concerns seriously, and they feel like "guinea pigs".
- The "Precautionary Principle"[19] should be invoked by placing a moratorium on some application practices (specifically aerial spraying) until these practices are proven safe.

In an effort to address their own health concerns, a few residents have taken steps to hire a forensic agronomist, test their own drinking water, collect and have their urine samples analyzed, and pay for air monitoring equipment and analysis. These residents want to know how pesticides move and act in the unique climate of the investigation area. In an effort to capture this information, they have educated themselves on the science of air and water monitoring and agronomics.

Summary

OHA believes that stress and community conflict in the investigation area negatively affects both individual and community health and well-being. This dynamic may impede future efforts to understand and respond to community concerns about pesticide exposures. The issue of pesticide use in general, and aerial applications in particular, has created conflict between neighbors and friends. One resident said that people who used to be friendly have stopped talking to her. Others have expressed their apologies to the investigation team for what they call embarrassing behavior - behavior they feel reflects poorly on their community. Many people have made it clear they do not know who to trust or what to believe. This type of polarization within rural communities is arguably more destructive and stressful than in more populated areas because people in rural areas or smaller communities may be more dependent on each other's relational resources and community capacity [57].

[19] The Science and Environmental Health Network describes the Precautionary Principle as follows: "When an activity raises threats of harm to human health or the environment, precautionary measures should be taken even if some cause and effect relationships are not fully established scientifically."

OHA has identified several causes of stress and conflict within the Highway 36 community, including the following:

- fear and anxiety about personal health, safety, and children's health;
- differing views on pesticide use and human and private property rights;
- ongoing concerns about the lack of adequate notifications and records of pesticide applications;
- anger and distrust of government agencies; and
- divisions within the community and existing social networks.

These stressors negatively affect individual community members and the Highway 36 community as a whole. OHA believes that formal mediation services may help to reduce community stress and improve community cohesion in the longer term. Mediation may also be necessary for the successful completion of the EI.

Progress Toward Answering Investigation Questions

Table 17 describes the EI team's progress toward answering the original EI questions. The table also highlights outstanding gaps in available information and identifies the types of activities that would help fill these information gaps. OHA drew from information gaps identified in this table to guide recommendations and the public health action plan.

Table 17. Summary of the Exposure Investigation Questions and Progress Toward Answer

Exposure Investigation Question	Progress Toward Answer	Conclusions	What else is needed to answer the question?
Are residents in the Highway 36 Corridor being exposed to pesticides or herbicides from local application practices?	• Fall 2011 sampling was designed to capture baseline conditions when known pesticide applications were minimal. As expected, overall results of fall 2011 sampling confirm that exposures to 2,4-D and atrazine were low among Highway 36 investigation area residents during the fall season. • Community-collected data from Spring 2011 indicate that exposures to 2,4-D and atrazine were occurring in Spring 2011.	1. This investigation did find evidence that residents of the investigation area were exposed to pesticides or herbicides in spring and fall 2011. While not possible to confirm that these observed exposures occurred as a result of local application practices or were from other sources, the evidence suggests that local applications that occurred near to and at the time the nine 24-hour subset samples were collected in spring 2011 may have contributed to the concentrations of pesticides detected in participants' urine.	Additional biologic testing, conducted to coincide with the timing and location of aerial application of pesticides that can be detected in urine would provide important evidence regarding the relationship between known applications of pesticide and detectable levels in local residents.
	If residents are being exposed:		
To what pesticides or herbicides are they being exposed?	• Spring and Fall 2011 urine data indicate that Highway 36 investigation area residents were exposed to 2,4-D, and Spring 2011 urine data indicate that residents were exposed to atrazine in the spring. • Fall environmental sampling indicates that exposure to pesticides other than 2,4-D was minimal. • The inability to measure pesticides	2. Residents in the Highway 36 investigation area had urinary biomarkers for exposure to 2,4-D in spring and fall 2011, and atrazine in spring 2011. We were unable to determine if tested residents in the investigation area had urinary biomarkers for exposure to pesticides other than 2,4-D and	Additional laboratory methods that allow for measurement of other pesticides in urine would enhance OHA's ability to answer this question.

Exposure Investigation Question	Progress Toward Answer	Conclusions	What else is needed to answer the question?
	other than 2,4-D and atrazine in urine is a significant technical limitation.	atrazine in spring or fall 2011. 3. Some Highway 36 investigation area residents may have been exposed to very low levels of DEET, fluoridone, or hexazinone in their drinking water during the fall of 2011 time-period. 4. Some Highway 36 investigation area residents may have been exposed to very low levels 2,4-D or glyphosate in their soil. 5. Some Highway 36 investigation area residents may have been exposed to very low levels of clopyralid in the air.	
To what levels are they being exposed?	• Fall 2011 urine data indicate that Highway 36 investigation area residents were exposed to low levels of 2,4-D at that time. • Spring 2011 urine data indicate that Highway 36 investigation area residents were exposed to levels of 2,4-D statistically higher than in the general U.S. population at that time and higher levels of both 2,4-D and atrazine in Spring than in the Fall.	6. In the spring of 2011, Highway 36 investigation area residents had higher levels of 2,4-D exposure than the general U.S. population. 7. In the fall of 2011, Highway 36 investigation area residents had urinary 2,4-D levels that were not statistically higher than the general U.S. population. 8. In the spring of 2011, urine samples from Highway 36 investigation area residents also had detectable levels of atrazine, but it is unknown how these	

Exposure Investigation Question	Progress Toward Answer	Conclusions	What else is needed to answer the question?
		levels compare to the general U.S. population.	
What are potential source(s) of the pesticides or herbicides to which they are exposed?	• Pre-application, spring 2011 urine results and pesticide application records data indicate that there are likely other sources of 2,4-D and atrazine exposure in Highway 36 investigation area residents that have not yet been identified with existing resources. • The nine 24-hour subset of urine samples collected in spring 2011, and four pesticide application records indicate that there may be an association between local pesticide applications and statistically significant increases in urinary atrazine metabolite levels.	9. There is insufficient information to confirm that local pesticide applications are the source of pesticides found in the urine of participating Highway 36 investigation area residents. However, there is evidence to suggest that some local aerial applications may be a contributing source of human exposure.	Additional information about non-regulated uses of 2,4-D and atrazine and environmental persistence would help to answer this question more fully. OHA will need continued access to pesticide application records data to accompany any future monitoring efforts.
What are potential routes (pathways) of residents' exposures?	• Fall 2011 environmental sampling ruled out drinking water, soil, and homegrown foods as routes of exposure for that specific time-period. • Community-collected environmental sampling from spring 2011 was insufficient to rule out any exposure routes for that time-period. • Lack of air monitoring data during the fall and spring pesticide application seasons represents a significant data gap. Without this air	10. We were unable to determine if air was a potential pathway of exposure to pesticides in the Highway 36 investigation area. 11. Drinking water can be eliminated as an exposure pathway for the 2,4-D and atrazine detected in Highway 36 investigation area residents' urine. 12. Soil sampled in the fall of 2011 can be eliminated as an exposure pathway for the 2,4-D	Widespread passive air monitoring before and during a pesticide application season, coupled with analysis for the appropriate pesticides, would provide valuable information about whether or not ambient air is an important exposure pathway for Highway 36

Exposure Investigation Question	Progress Toward Answer	Conclusions	What else is needed to answer the question?
	monitoring data, exposure via ambient air from either direct drift or volatilization cannot be ruled out.	and atrazine detected in Highway 36 investigation area residents' urine. 13. Homegrown food sampled in the fall of 2011 can be eliminated as an exposure pathway.	investigation area residents.
What health risks are associated with these exposures?	• Urinary 2,4-D levels in Fall and Spring of 2011 were below toxicity-based BEs, indicating that measured 2,4-D levels are not associated with health risks. • OHA cannot conclude whether or not atrazine metabolite levels measured in Highway 36 investigation area residents' urine in Spring 2011 could harm people's health because there is no toxicity-based threshold value for atrazine in urine against which these measured levels can be compared.	14. The levels of 2,4-D measured in Highway 36 investigation area residents' urine in spring and fall 2011 were below levels expected to harm people's health. 15. We cannot determine whether the levels of atrazine metabolites measured in Highway 36 investigation area residents' urine in spring 2011 could harm people's health. 16. Drinking or contacting domestic water with pesticides at the concentrations detected in some Highway 36 investigation area properties is not expected to harm people's health. 17. Contact with soil with pesticides at the concentrations detected in the fall of 2011 in some Highway 36 investigation	BEs for additional pesticides, especially atrazine metabolites, would greatly enhance OHA's ability to make health determinations based on urinary pesticide concentrations. RfCs for pesticides in ambient air will be very helpful in evaluating air monitoring data collected in the future for health significance.

Exposure Investigation Question	Progress Toward Answer	Conclusions	What else is needed to answer the question?
		area soil is not expected to harm people's health. 18. Handling or consuming garden vegetables, berries, eggs, milk or honey from the Highway 36 investigation area from fall 2011 will not harm people's health.	

Conclusions

As a result of this EI, OHA reached *twenty-two* important conclusions addressing the questions about the presence, type and source of exposure to pesticides in the Highway 36 investigation area:

OHA reached *one* conclusion related to the question: **Are residents in the Highway 36 Corridor being exposed to pesticides from local application practices?**

> **Conclusion 1:** This investigation did find evidence that residents of the investigation area were exposed to pesticides or herbicides in spring and fall 2011. However, it was not possible to confirm if these observed exposures occurred as a result of local applications practices or were from other sources.

OHA reached *four* conclusions related to the question: **To what pesticides are they being exposed?**

> **Conclusion 2:** Residents in the Highway 36 investigation area had urinary biomarkers for exposure to 2,4-D in spring and fall 2011, and atrazine in spring 2011. We were unable to determine if participants in the investigation area had urinary biomarkers for exposure to pesticides <u>other</u> than 2,4-D and atrazine in spring or fall 2011.

> **Conclusion 3:** Some Highway 36 investigation area residents may have been exposed to very low levels of DEET, fluoridone, or hexazinone in their drinking water.

> **Conclusion 4:** Some Highway 36 investigation area residents may have been exposed to very low levels 2,4-D or glyphosate in their soil.

> **Conclusion 5:** Some Highway 36 investigation area residents may have been exposed to very low levels of clopyralid in the air.

OHA reached *three* conclusions related to the question: **To what levels are they being exposed?**

> **Conclusion 6:** In the spring of 2011, Highway 36 investigation area residents had higher levels of 2,4-D exposure than the general U.S. population.

> **Conclusion 7:** In the fall of 2011, Highway 36 investigation area residents had urinary 2,4-D levels that were not statistically higher than the general U.S. population.

> **Conclusion 8:** In the spring of 2011, urine samples from Highway 36 investigation area residents also had detectable levels of atrazine metabolites, but it is unknown how these levels compare to the general U.S. population.

OHA reached *two* conclusions related to the question: **What are potential source(s) of the pesticides to which they are exposed?**

Conclusion 9:
There are additional sources of 2,4-D and atrazine in the investigation area that are not accounted for in the pesticide application records available to the investigation team.

Conclusion 10:
Statistical associations suggest that four local aerial applications of atrazine and 2,4-D to forestland may have contributed to an increase in urinary atrazine metabolite levels in samples collected from nine participants within 24 hours of those applications.

OHA reached *five* conclusions related to the question: **What are potential routes (pathways) of residents' exposures?**

Conclusion 11: We were unable to determine whether air is a pathway of exposure to pesticides in the Highway 36 investigation area.

Conclusion 12: Drinking water was eliminated as an exposure pathway for 2,4-D and atrazine in the fall of 2011.

Conclusion 13: Soil sampled in the fall of 2011 was eliminated as an exposure pathway for the 2,4-D and atrazine detected in Highway 36 investigation area residents' urine.

Conclusion 14: Wild or homegrown food products sampled in the fall of 2011 were eliminated as an exposure pathway in fall of 2011.

Conclusion 15: Concentrations of pesticides in drinking water, soil and homegrown food in the spring of 2011 and other seasons and years are unknown.

OHA reached *five* conclusions related to the question: **What health risks are associated with these exposures?**

Conclusion 16: The levels of 2,4-D measured in Highway 36 investigation area residents' urine in spring and fall 2011 were below levels expected to harm people's health.

Conclusion 17: We cannot determine whether the levels of atrazine metabolites measured in Highway 36 investigation area residents' urine in spring 2011 could harm people's health.

Conclusion 18: Drinking or contacting domestic water with concentrations of pesticides detected in some Highway 36 investigation area properties in fall 2011 is not expected to harm people's health.

Conclusion 19: Contact with soil containing pesticides at the concentrations detected in the fall of 2011 in some Highway 36 investigation area soil is not expected to harm people's health.

Conclusion 20: Handling or consuming garden vegetables, berries, eggs, milk or honey collected from the Highway 36 EI participants' homes in fall 2011 will not lead to harmful health effects related to pesticide exposure.

OHA reached *two* additional conclusions related to the impacts to the EI and to the health of community members from community conflict.

Conclusion 21: Divisions and hostility within the community related to pesticide use, property rights and land use are creating significant stressors on many individual community members and on the community as a whole.

Conclusion 22: Leadership activity within the community has been oriented toward debating issues of land use, pesticide use, and property rights. No formal or informal leader has yet emerged who has a mediating influence on these differences. Formal mediation services for the Highway 36 community may be necessary for both the successful completion of the EI and for the important progress needed to reduce community stress and improve community cohesion in the longer term.

Recommendations

Pertaining to the results of this EI, OHA recommends that:

1. US EPA work with the EI team on developing a sampling and analysis plan designed to evaluate exposures to pesticides in air and to address gaps in the data needed to answer EI questions. At the time of publication of this report, passive air monitoring over several application seasons appears to be the best option to collect community-wide air data.
2. ODA and ODF continue to provide pesticide application data as needed to interpret air sampling (or other) data collected as part of this investigation.
3. State and federal agencies involved in the ongoing EI develop an implementation plan that includes identification of necessary resources to carry out activities appropriate for each agency's role in this effort.

Pertaining to broader and/or longer-term issues identified by the EI, OHA recommends that:

1. State agencies continue to collaborate on determining best practices that would protect human populations from pesticide exposures.
2. ODA and ODF work with pesticide applicators to develop consistent pesticide application record-keeping processes to ensure that application record data are accurately maintained and usable.
3. State agencies explore the feasibility of implementing a system that would allow people to be notified of imminent pesticide applications in such time and with such specificity that they could take action to avoid exposure to those applications. Such policies could include adoption of systems developed by other jurisdictions, or modification of existing regulatory systems designed to monitor pesticides applications.

4. State and federal agencies involved in the ongoing EI develop an implementation plan to address these recommendations, including the identification of resources to carry out activities appropriate for each agency's role in serving the communities of Oregon. That plan should include a recommendation on how the agencies should coordinate, collaborate and share resources.
5. Community members, including local elected officials and other community leaders, consider seeking the assistance of a professional mediation group to address immediate and long-term conflict within the community and identify actions to move this conflict toward resolution.

Public Health Action Plan

Public health actions completed:

- The EI team collected urine and environmental samples in fall 2011, and communicated individual results back to EI participants in winter 2011/2012.
- The EI team hosted two public meetings (July 2011 and April 2012) and one open house (November 2011) in Blachly, Oregon.
- ATSDR released a report on the fall 2011 urine sample results in March 2012.
- OHA led outreach activities for the EI, including recruiting participants, coordinating three community meetings and one open house, conducting surveys and questionnaires, determining chain of custody for the community-collected urine samples, and developing the Highway 36 EI web page and listserv, press releases, flyers, factsheets, and other communication materials.
- Since 2011, OHA has participated with ODF, ODA, and DEQ on the Water Quality Pesticide Management team, which serves as the scientific advisory committee for the Pesticide Stewardship Partnership Program aiming to reduce pesticide movement into waters of the state.
- OHA's role as co-chair of PARC, has been to provide a public health perspective on appropriate responses for human pesticide exposures in Oregon.
- OHA tracks acute pesticide exposures in Oregonians as part of its Pesticide Exposure, Safety and Tracking program (PEST). The EPA Office of Pesticide Programs reviews the findings from PEST (along with other states' surveillance programs), when determining updates to pesticide labels.

Public health actions planned:

OHA will:

- Work with state and federal partners, community members, and other stakeholders to implement the recommendations in this report.
- Provide updates through the Highway 36 web page and listserv about findings from:
    - The comparison of application records from 2011 to application records from 2009 and 2010 to determine if there were noticeable (substantial) changes in pesticide application practices after the EI was initiated in 2011.
    - Air sampling data once it is collected by the EPA.

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Report Preparation

This Public Health Assessment for the Highway 36 Corridor site was prepared by the Oregon Health Authority under a cooperative agreement with the federal Agency for Toxic Substances and Disease Registry (ATSDR). This report was not reviewed or cleared by ATSDR.

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Appendix A: Response to public comments

This appendix describes how EHAP addressed and/or incorporated public comments into this final report of the Highway 36 Exposure Investigation Public Health Assessment. OHA received comments from 52 individuals, community groups, industry representatives and legal teams. Some comments were very extensive.

Since many comments contained multiple topics, we grouped statements together that were similar in nature. We have presented many comments verbatim, to minimize the chances of miscommunicating or misinterpreting the comment. In cases where two or more comments expressed the same question or concern, we paraphrased them for clarity.

OHA does not list names or affiliations with these comments, in order to protect the commenter's identity. In some cases, we have left names in a comment, when a group or company refers to itself within the comment. Each comment is numbered, and OHA's response follows in italics.
Visit www.healthoregon.org/ehap to access all (redacted) comments received by OHA.

Comment 1: "It is incomprehensible how the agency could avoid concluding that forestry aerial sprays were the source of the atrazine metabolites found in residents' urine. The only documented use of atrazine in the study area was in forestry aerial sprays, and urine levels tested shortly after aerial applications of atrazine showed significant increases above earlier levels, as documented in the draft report. Atrazine is a Restricted Use Pesticide, making it highly unlikely that residents in the study area use it on their property in any way."

Response: Many commenters made similar statements. In response - and based on additional analysis, OHA has revised conclusion 9 and added a new conclusion 10 to clarify the findings. Conclusion 9 is now focused on the evidence that there were additional sources of atrazine (and 2,4-D) not accounted for in the application records available to OHA. Based on what we now know, the 13 spring samples that were collected before any known pesticide application, contained levels of urinary atrazine metabolites (and 2,4-D) that were similar to the 26 samples collected at varying times after known applications (Table 10). In other words, all 39 spring 2011 samples had statistically higher levels than the fall 2011 samples, including those 13 spring samples that were collected before any known application.

In addition, OHA developed a new conclusion (#10) that identifies four aerial applications of 2,4-D and atrazine as likely contributors, in whole or in part, to the statistically higher atrazine metabolite levels in the nine 24-hour subset samples. The nine, 24-hour subset samples are those that were part of the original 39 spring samples, but were collected within 24 hours of a nearby spray. When compared to the other 30 spring samples, these nine subset samples contained statistically higher levels of atrazine metabolites.

However, in order to confirm that aerial sprays or ground applications are the actual sources of this statistical difference, OHA would need also to have simultaneous environmental sampling data to detail how atrazine persisted and traveled from the application sites to the nine participants' locations. This difference between the nine 24-hour subset urine samples and the other 30 spring 2011 urine samples could also be influenced, at least in part, by temporary changes in the amounts of pesticides released by *unknown source(s) of atrazine and 2,4-D that were taking place at the same time. These sources have not been identified in currently available application records.*

Comment 2: "Determination of 'Biological Equivalency (BE)'
The Interim PHA was unable to compare atrazine results with a bio-monitoring equivalent (BE) because there is not a BE for atrazine. However, information on derivation of the BE for atrazine and its metabolites was discussed and submitted by [redacted] (September 21, 2011) to the OHA, Oregon Department of Agriculture, Oregon Department of Environmental Quality, ATSDR and EPA Region 10. Information on derivation of an atrazine BE was based on the extensive atrazine database and by application of a Physiologically Based Pharmacokinetic (PBPK) model. An Excel spreadsheet-based Forward- and Back-Calculator tool was provided."

Response: OHA appreciates the provision of these resources. However, OHA is constrained to use publicly available, peer-reviewed resources to evaluate locally collected data.

Comment 3: "Based on the PBPK model, the urine detections in samples taken by some community members in spring 2011 are not plausible. Samples were taken to purportedly represent "pre- and post-spraying" and assumed passive exposure via air or water. As indicated in [redacted] September 21, 2011 submission, atrazine is rapidly metabolized, predominately to diamino-chloro-s-triazine (DACT), within hours of exposure. Furthermore, worker exposure studies have clearly characterized likely urine concentrations of DACT after known levels of exposure. This knowledge, together with atrazine's low vapor pressure and the application of the Calculator render the results from the 2011 "pre-spray" samples as unrealistic."

Response: OHA places confidence in measured data over modeled predictions. Regardless of how these data may appear, they represent actual measurements, and the investigation team is tasked with explaining those measurements to the best of our ability. In addition, DACT was the primary metabolite measured in spring 2011 urine samples, which is consistent with previous studies mentioned in the comment.

Comment 4: "The report does not document the use of adjuvants (various additives) that were applied concurrently with pesticides. These products, which are not subject to the same labeling requirements as active ingredients, are used for a variety of purposes, including making the product stick to vegetation, reducing foam, and reducing drift. Many of these products are considered toxic in their own right, yet OHA did not examine their use in the study area."

Response: This is a limitation of the investigation. Application records do not require that applicators include specific chemical identities for adjuvants. The ODF records do require that applicators list product names for adjuvants, but not the specific chemicals in the products. Typically they were described as "surfactants," "dyes," and "defoamers." This level of information is insufficient to determine what specific chemicals to test for in the environment or in urine in the Highway 36 Corridor. Without exposure data, it is impossible to evaluate the risk to human health.

ODA's record keeping requirements apply only to pesticides, not adjuvants. ODF explained that their requirements obligate applicators to record the brand name (product name) of all chemicals, including adjuvants in their application records. ODF explains:

"An ODF compliance assessment against Forest Practices Act (FPA) standards found compliance rates at or above 90% for recorded pesticide application locations, listed pesticides and operation start/end dates. The compliance rate for recording adjuvant information was 89%. While the audit indicates areas with lower compliance, the records do provide valid data on what products were applied, where and when. Education and outreach efforts have already begun to clarify expectations of pesticide application record contents, including an update to the pesticide application form (see http://www.oregon.gov/ODF/privateforests/pages/pesticides.aspx), and will continue into 2014."

Comment 5: "The OHA draft report contains total amounts for various pesticides, but using two different units, pounds and gallons, based on the pesticide formulation used. Then in Table 19, colors are used to indicate which pesticides were used the most. That table indicates that hexazinone was the pesticide used the most in the study area in 2011. It is possible to convert the liquid chemicals from gallons to pounds by using the density or other information contained on the product's label or MSDS (Material Safety Data Sheet)…. Thus, the application records provided by ODF show that forestry accounted for over 9 tons of pesticide products applied in the Triangle Lake Study Area during the year 2011. It is also clear, after converting the products to the same units, that hexazinone was not the most heavily used pesticide in the watershed. In fact, atrazine was the most-used pesticide in the watershed, followed by glyphosate, then 2,4-D, then imazapyr, and only then hexazinone. It should also be noted that while the amounts of metsulfuron methyl and sulfometuron methyl applied were relatively small, that the application rates for these two chemicals are far lower than the other chemicals used."

Response: OHA acknowledges that information about the amounts of pesticides applied is presented in mixed units, as they were received by ODA and ODF. The total and relative amounts of pesticide applied are pieces of information that are tangential to the exposure investigation. OHA's focus is human exposure relative to the toxicity of the active ingredients. Because some active ingredients are more toxic than others, absolute amount applied relative to other active ingredients is not a relevant measure of human health risk.

Comment 6: "In reviewing all of the pesticide application records provided by ODF, I found that of the 244 records provided, at least 65 (27%) lacked one or more of the items of information required by ODF rules for pesticide applicators on forest land. That is a dismal compliance rate, and has clearly affected the ability of investigators to accurately determine what products were applied, when, and where."

Response: ODF responded, "An Oregon Department of Forestry (ODF) compliance assessment comparing Forest Practices Act (FPA) standards found compliance rates at or above 90% for recorded pesticide application locations, listed pesticides and operation start/end dates. The lowest compliance rate was observed with the requirement to record the carrier type (69%). Most of the described applications were suitable for a water carrier and applicators probably did not consider that water needed to be listed as a carrier. As stated in a previous comment, the audit indicates there are areas with lower compliance. However, the records do provide valid data on what products were applied, where and when. Education and outreach efforts have already begun to clarify expectations of pesticide application record contents, including an update to the pesticide application form (see http://www.oregon.gov/ODF/privateforests/pages/pesticides.aspx), and will continue into 2014."

Comment 7: Multiple commenters independently obtained pesticide application records from ODF. Some of these commenters identified discrepancies between the numbers of records they obtained and the numbers obtained and reported by OHA.

Response: OHA has been in communication with these commenters and ODF. OHA has resolved these discrepancies and this final report accounts for all application records. The numbers of unique application records counted by independent commenters and OHA now match. This application record information is in Appendix B. None of the additional application records occurred during urine or environmental sample collection in the fall or spring of 2011 or contained either of the pesticides tested in urine samples.

Comment 8: "There are two errors in the chart on page 33 showing the Siuslaw Watershed Guardians' water quality testing results. Both are in the column showing the results for Hexazinone:
a. In the first row, showing the result for the original sample at Fish Creek near the Mouth, the amount of Hexazinone per POCIS should be 64 nanograms, not the 50.7 that is shown. The lab report shows 192 nanograms in the sample; therefore, the correct entry should be 192 divided by 3, or 64.
b. In the sixth row, showing the result for the original sample at Nelson Creek downstream of Almaisie Creek, the amount of Hexazinone per POCIS should be 13.6 nanograms, not the Not Detected that is shown. The lab report shows 40.8 nanograms in the sample; therefore the correct entry should be 40.8 divided by 3, or 13.6."

*Response: OHA made these corrections in this final version of the report. See page 36 [*Table 14*].*

Comment 9: "The OHA report indicates, at page 32, that the Oregon Department of Environmental Quality 'typically' finds atrazine and hexazinone in waters throughout the state. However, a review of sampling sites used by DEQ shows that these detections have typically been in larger streams draining much larger watersheds that typically contain many land uses, including agriculture. The sampling sites used by the Siuslaw Watershed Guardians were, with the exception of the Lake Creek sampler, sites on very small streams draining very small watersheds where forestry is typically the primary land use."

Response: OHA altered the text in the report to reflect that DEQ's typical atrazine detections by POCIS sampling are from larger streams draining multiple land use types including agriculture (See page 35).

Comment 10: "Other potential sources of pesticides in the watershed which have not been investigated include Triangle Lake itself (water, sediments), as well as air-borne contaminants released when treated lumber is burned."

Other comments stated that limited environmental sampling has led to uncertainties about pesticide exposures.

Response: It is true the investigation team has not sampled Triangle Lake or other surface waters aside from Little Lake. When treated lumber is burned, the pesticides are destroyed and so would not become a source of contamination. OHA acknowledges that environmental sampling data are limited and that conclusions of the report are limited to the available data. Given limited resources, environmental sampling was prioritized to characterize those pathways with the greatest potential for the largest exposures.

Comment 11: "The POCIS sampler that was located in Lake Creek above Fish Creek showed detections of Atrazine, Desethyl Atrazine and Hexazinone, but the pesticide application records show that there were no prior applications of those chemicals in the watershed above the sampling point. This is strong evidence that the contamination occurred through drift from pesticide applications in adjoining watersheds."

Response: This is one line of evidence that pesticides can travel some distance from the application site. Other evidence is referenced in the report (Page 31). However, without quantitative information about ambient concentrations in the media (i.e. air, water, soil) that people are exposed to, it is difficult to know the potential impact of this movement on the health of people in the area.

Comment 12: "On page 4 of the draft report, OHA makes the following statement: 'This investigation documented the presence of 2,4-D and atrazine in the urine of residents. There was a drop in those levels between the spring and fall 2011 for reasons that are currently unknown.' This statement is very hard to understand, given that the application records examined by OHA show very clearly that atrazine and 2,4-D were applied aerially in the spring but were not applied at all in the fall. Table 19 on page 64 of the draft report shows no applications of either of these chemicals after May (although another section of these comments show that there was an application of 2,4-D in June which had been mislabeled by ODF and was therefore overlooked by the OHA). The reason for the drop in atrazine and 2,4-D in urine levels is obvious: the timber industry uses these chemicals only in the spring. It is extremely puzzling why OHA could not draw that very obvious conclusion. Maintaining a rigorous scientific study does not require abandoning logic and common sense."

Response: The 13 pre-application samples from Spring 2011 make it difficult to simply conclude that the lower levels in fall 2011 are the result of no recent timberland applications. There were also no application records showing use of 2,4-D or atrazine in the several months leading up to these 13 samples, yet the 2,4-D and atrazine metabolite concentrations in these 13 samples were significantly higher than fall 2011 samples.

Comment 13: "The original investigation design, as described on page 16 of the draft report, was to include urine sampling before and after nearby ground or aerial spraying in the spring of 2012. However, as explained on page 23 of the draft report, the spring sampling was suspended on March 8, 2012, 'because the areas that were slated for applications of 2,4-D and/or atrazine were in remote locations which have very few residents.' On page 7 of the draft report, OHA states that 'It is not known if the Exposure Investigation resulted in changes to pesticide application practices in the investigation area, and therefore if exposure conditions have changed for Highway 36 corridor residents.' In fact, the pesticide application records provided by ODF for the years 2009 through 2011 document very clearly that for all three years, atrazine and 2,4-D were heavily applied in the study area during the spring. The records document that the following amounts of 2,4-D and atrazine were applied in the study area for the years 2009 through 2011: (see Table 2 in second tab). Application records from 2012 are not available; however, according to the OHA report, no sprays of 2,4-D or atrazine were planned for the spring for the study area. This is totally contrary to the pattern, which is clearly established by the records for 2009 through 2011, showing heavy use in the study area of atrazine and 2,4-D in the spring. Thus it seems fairly clear that the timber companies in the study area changed their practices by avoiding the use of

2,4-D and atrazine (the only two chemicals which OHA can test for in urine) and instead using other chemicals in their place."

Response: OHA did not have the resources to enter and analyze pesticide application records for 2009-2010. Analyzing trends of pesticide use over time is a task we have slated for a future report as the investigation continues as mentioned in the "Public Health Action Plan" in the summary section and on page 58. Your comments and work will give us a head start as we begin that process, and they are much appreciated.

Comment 14: "I urge those in charge of this investigation to expand the study area to include all of the state, and to redesign the study in such a way that the timber companies and pesticide applicators will not know when or where samples are being taken. I urge those in charge to invest appropriate resources so that adequate air, water and biological samples can be taken that will provide answers rather than simply raise more questions. I urge those in charge to pursue air testing for all chemicals used on forest and agricultural lands in Oregon, and to conduct such tests in adequate numbers that conclusions can be drawn."

Response: The investigation team does not have the resources to expand this investigation beyond the current area. However, if the EPA is successful in developing and deploying passive air samplers in the investigation area, they could be used in other areas of the state as well. EPA and DEQ will coordinate this work. EPA's efforts are focused on developing passive samplers that would capture the active ingredients currently used in forestry. Passive samplers would allow for monitoring over time without coordination with landowners.

A major difficulty in designing urine sampling without coordinating with landowners is that samples have to be collected within 24 hours of an application. Without knowing exactly when an application is to occur, it is logistically challenging to collect samples within that 24-hour window.

Comment 15: "OHA continues to use "pesticide" data when herbicide-specific data is available. The synergistic effects alluded to are generally with much more toxic insecticides. Available evidence on herbicides used in combination finds more antagonistic combinations than synergistic. And the worst-case scenario was only a multiple of two times toxicity (see Acute Toxicity of Commonly Used Forestry Herbicide Mixtures to *Ceriodaphnia dubia* and *Pimephales promeias*," Environmental Toxicology 27(12): 671-684). The claim of "potentially greater risk" overstates available information and appears to bias what is known about the health effects of herbicides."

Response: The field of toxicology is making advances in understanding the effects of complex mixtures. However, this area of study is still young and is associated with a lot of uncertainty. Where uncertainty exists, it is the role of public health agencies to err on the side of caution. The text of the report does not claim that there is greater risk, only that there is potential for greater risk. Another area of uncertainty is that the complex mixtures in question are not simply multiple herbicidal active ingredients, but also includes multiple adjuvants. Application records do not specify what chemicals are used as adjuvants. When confronted with these unknowns, OHA is constrained to assume that some additive or even synergistic mixture effects are possible.

Comment 16: "On page 21 and 23, the PHA concludes that only two commercial applications of pesticides occurred prior to the urine sampling on August 30 and 31, and that these were ground pesticide applications. However, according to the official spray records obtained by [redacted], one aerial spray took place on 8/18 and three aerial sprays took place 8/28-29. OHA did not do urine testing for the chemicals used in late August, 2011, nonetheless, it is important to include the full data set in the report."

Response: The section of the report mentioned here states that these were the only applications occurring <u>*during*</u> *the sample collection – not* <u>*prior to*</u> *application. The 8/18 application was considered too early to have had a bearing on sampling results, and as indicated, it did not include either 2,4-D or atrazine. However, OHA agrees that the 8/28-29 aerial applications were close enough to the sample collections to warrant mentioning in the report, and they have been added to the section where this is discussed (Page 23). As noted, none of these four applications included 2,4-D or atrazine, so they would not have influenced urine results for these two pesticides.*

Comment 17: "The OHA draft report mentions, but does not discuss, the possibility of volatilization of pesticides as a possible source in the study area. A recent study by the U.S.D.A.'s Agricultural Research Service indicates that under certain conditions, more pesticide product can be lost to volatilization than to surface runoff. (*Comparison of Field-scale Herbicide Runoff and Volatilization Losses: An Eight-Year Field Investigation*, Timothy J. Gish, John H. Prueger, Craig S.T. Daughtry, William P. Kustas, Lynn G. McKee, Andrew L. Russ and Jerry L. Hatfield, Journal of Environmental Quality 2011 40: 5: 1432-1442doi:10.2134/jeq2010.0092.) The study showed that revolatilization is significant when ground moisture is high and temperatures are increasing, the exact conditions in Oregon in the spring. A prepublication version of this study is included as Exhibit F."

Response: OHA agrees that volatilization is an exposure pathway that has not been adequately addressed to this point. It is mentioned in Table 1 (page 17) as a potential exposure pathway. Table 17 (page 50) mentions that volatilization cannot be ruled out as an exposure pathway and that air monitoring is needed in order to determine whether or not it is a significant pathway of exposure in the Hwy 36 area. OHA has recommended that EPA develop and deploy passive air monitoring devices that can be used to determine concentrations of herbicides in ambient air. Passive air sampling will not, in itself, allow us to differentiate volatilization from drift, but pesticide application records covering the period of monitor deployment can be used in combination with passive monitoring results to distinguish them.

Comment 18: "Parts of the Interim PHA mischaracterize the toxicological & human health data base for atrazine. Appendix E uses two short paragraphs to describe the extensive toxicological database for atrazine and does not adequately represent the current state of knowledge on atrazine. Several statements in Appendix E can be taken out of context if not taking into account environmental exposures. The Joint FAO/WHO Meeting on Pesticide Residues (JMPR) conducted a toxicological evaluation of atrazine in 2007 and published it in 2009. The JMPR states that 'The database on atrazine was extensive, consisting of a comprehensive set of GLP-compliant guideline studies with atrazine and its four key metabolites, as well as a large number of published studies' and 'investigations of other modes of action did not provide any evidence that atrazine had intrinsic estrogenic activity or that it increased aromatase activity in vivo' (WHO, 2009)."

Response: It was not OHA's intention for Appendix E (now appendix F on page 126) or any other portion of the PHA to serve as a comprehensive literature review for atrazine. Readers are referred to ATSDR's Toxicological Profile on atrazine for a more detailed and complete review. The PHA does not claim that atrazine causes cancer, though it does document some community members' concerns that it might. The PHA also does not claim that atrazine is intrinsically estrogenic. However, the extensive toxicological record on atrazine clearly demonstrates disruption of other endocrine pathways and interference with reproduction in animal models. These highly reproducible and consistent findings demonstrate that atrazine is an endocrine disruptor and that at sufficient doses can and does impair reproduction and cause developmental toxicity in animal models. As with all toxicological questions, actual risk depends on the dose.

Comment 19: "In 2010, the atrazine drinking-water guideline prepared for the Third Edition of the WHO Guidelines for Drinking-water Quality was revised following the 2008 publication of the 2007 Joint FAO/WHO Meeting on Pesticide Residues (JMPR) evaluation of atrazine and its environmental metabolites (WHO, 2008) http://www.fao.org/docrep/010/a1556e/a1556e00.HTM.

Based on the 2007 JMPR review, the Guideline Value of 100 ppb was derived for the sum of atrazine and its chloro-s-triazines in 2010 (WHO, 2010) http://www.who.int/water_sanitation_health/dwq/chemicals/dwq_background_20100701_en.pdf."

Response: As the agency regulating public drinking water safety in Oregon, OHA uses the current Maximum Contaminant Level (MCL) enforced by the EPA. This MCL is currently 3 ppb.

Comment 20: "Limited information provided in Appendix E fails to represent the comprehensive toxicological database on atrazine, and is solely "hazard" based, thereby ignoring potential exposures based on relevant environmental concentrations. PHA Question 2 (e) asks, "What health risks are associated with these exposures?" Scientifically valid data on both hazard and exposure are required to conduct an appropriate characterization of potential risk associated with atrazine. http://www.epa.gov/risk_assessment/basicinformation.htm#risk."

Response: See response to comment 18 regarding limited information in Appendix E (now Appendix F).

OHA has added a sentence to the end of the first paragraph on atrazine in Appendix E (now Appendix F) stating "As with all chemical exposures the severity and risk of health effects depends on a person's actual dose."

Toxicity values for atrazine are based on administered dose (e.g. EPA's oral reference dose or ATSDR's Minimal Risk Level). In the absence of a biomonitoring equivalent (BE), OHA was not able to quantitatively compare measured concentrations of atrazine metabolites in urine to an oral dose. Without this comparison, it was not possible for OHA to determine which of the potential health effects of atrazine may correlate to these measured exposures in the investigation area. For these reasons, OHA was unable to conclude whether or not measured atrazine exposures in Hwy 36 area residents could harm their health.

Comment 21: "On page 1 of the draft report, it is stated that community collected urine, water and air samples were analyzed by privately contracted analytical laboratories at Emory University in Atlanta, Georgia. That statement is correct only regarding the urine samples; the air and water samples were analyzed by Anatek Laboratories in Moscow, Idaho. On page 62 of the draft report, the paragraph between the figure and table summarizes Table 18, but fails to mention the 18 documented roadside applications of pesticides. It should also be noted that most of these roadside applications were done on private timberland by industrial timber companies."

Response: OHA corrected these errors in this final version of the PHA.

Comment 22: "The OHA report mentions only briefly the potential synergistic effects of combinations of pesticides such as the frequent combinations of 2,4-D and atrazine used aerially in the study area. So-called "tank mixes" are very common for both ground and aerial sprays, as the application records document clearly. Another combination of four pesticides (glyphosate, imazapyr, metsulfuron methyl and sulfometuron methyl) is frequently applied in the study area, sometimes in combination with additional adjuvants such as methylated seed oil."

Response: The investigation summarized in this report was subject to several limitations, chief of which was the available data on which to base conclusions. Concerns for the health effects of pesticides alone or in combination are understandable. However, in our work we are held to rigorous standards of scientific evidence so that conclusions drawn can be defended. We were only able to test for 2,4-D and atrazine individually and the possible human health effects of specific amounts of these two chemicals in combination is unknown. Gaps in the data are unsatisfactory to all parties, and a valid cause for concern. The Highway 36 / Triangle Lake Exposure Investigation should be seen as one step in a process of effective and appropriate scientific inquiry to protect the health of the community. The scope of OHA's involvement in future efforts is in the Public Health Action Plan section of the document. Recommendations of this report outline efforts led by other agencies.

Comment 23: Many commenters expressed concern about OHA's treatment of the statistical difference between the urinary 2,4-D levels of fall 2011 EI participants and the general U.S. population 75^{th} percentile (p-value 0.06 in Table 3). Some commenters said it was inappropriate for a state agency to use phrases like "approaches statistical significance," claiming p-values are designed to be objective, binary pass/fail tests. Other commenters said that OHA should call a p-value of 0.06 close enough to be statistically significant, arguing that additional factors should be weighed considering significance of the result.

Response: In all fields of study, the numerical value at which statistical significance is declared is a threshold set by "alpha"; this corresponds to the probability that the results would occur 1-alpha percent of the time if the scenario were repeated many times. Most fields of study accept an alpha of 0.05 (95% confidence level that the results would repeat) as a conservative measure of statistical significance; however, some fields of study will consider and report alphas of 0.10 corresponding to a 90% confidence level. Many fields of study choose to report findings of alphas less than 0.05 as significant and alphas between 0.05 and 0.10 as marginally significant, as we have here.

The p-value in itself simply describes the probability that a given result could have occurred by random chance. In this case, there is a probability of 0.06 or 6% that the observed difference between EI participants and the general U.S. population could have happened by random chance and a 94% chance that the difference between the two groups is a true difference and not random. In other words, if we *repeated the sampling 100 times, we would expect true differences 94 of those times. Language in the report has been altered to reflect that the distribution of urinary 2,4-D in the two populations (EI participants and the general US population 75^{th} percentile)is somewhat different.*

In summary, the difference between distributions of urinary 2,4-D concentrations in EI participants in fall 2011 and the general U.S. population appear to be slightly different in the upper quartile. There are more EI participants within the upper quartile of the expected range than would be expected. In other words, EI participants were still within the expected range as defined by 95^{th} percentile of NHANES, just distributed at the higher end of the range.

OHA changed language in the report to clarify significance levels (see page 20). OHA also changed language to clarify that the range, as defined by comparing 95^{th} percentiles of El participants and NHANES, is as expected and that the distribution within that range may be different (as measured by a marginally significant p-value=0.06) when comparing 75^{th} percentiles.

Comment 24: "The Oregon Health Authority also opted to exclude a child, under six years of age because 'there are no NHANES values for comparison for children under six years old. We believe that OHA should include this child and reevaluate the statistical significance of the presence of 2,4-D in participants' urine. Had OHA included this child, then the p-value of the 75th percentile finding would likely have been statistically significant, i.e., <0.05. We request that OHA review its analysis and determine whether inclusion of this participant creates a statistically significant finding."

Response: OHA could not include the two children younger than six years in the analysis for the report itself for the reasons stated. However, OHA did test for significance with the two additional children included. Under these conditions, the p-value went below 0.05 indicating statistical significance for the comparison of Highway 36 residents to the NHANES 75^{th} percentile. The p-value for the comparison of Highway 36 residents to the 95^{th} percentile did not approach significance. Thus, the overall conclusions related to the comparison of fall 2011 urine samples to NHANES would not have changed even if the two children had been included. See response to Comment 23 for more discussion of statistical significance and meaning of p-values.

Comment 25: "On page 22 of the report under "Summary of Fall 2011 Sampling", the second bullet point states that: "[B]ecause statistical significance tests on urinary 2,4-D levels were equivocal, OHA cannot conclude whether EI participants were statistically different than the general U. S. population with respect to urinary 2,4-D levels at the time of sampling." This assertion is contradictory to the actual analysis of the data summarized on pages 17-18. Comparisons to the NHANES 90th percentile show that "this number was not higher than expected". Even when the results were compared to the arbitrary 75th percentile, the numbers were not statistically significant. The 2,4-D concentrations from the fall 2011 sampling show that the numbers are what should be expected for any like population in the United States. That is what the report should reflect."

Response: Statistical tests do not indicate EI participants' samples were higher than the general population at the time of sampling. Comparing NHANES 75th percentile with EI participants provided a p-value=0.06; this suggests, with 90% confidence, that the distribution of EI participants levels in the upper quartile may differ from the general population. Together these results suggest that individuals in *the EI population did not show statistically higher 2,4-D levels than the general population; however, individuals may be more likely to have levels in the high end of the expected range. Language in the report (page 20) has been changed to clarify the difference between statistically higher levels (or range) and statistically different distributions.*

Comment 26: "This report suggests that landowners deliberately changed application practices because of the investigation. This accusation should have some basis if it is to appear in the report. Contrary to the assertion made here, a review of application records show no major changes in application practices after the El began. The assessment implies that forestry landowners have not acted in good faith regarding the investigation, and that is simply not true. This statement should be backed up with data or removed from the report. This section of the report highlights the lack of understanding about forestry operations that has been a persistent issue throughout the Highway 36 Exposure Investigation. We encourage OHA to better engage with forestry landowners and the Oregon Department of Forestry to gain a better understanding of how our private forestlands are managed. After repeated attempts to explain our industry, OHA appears either unwilling or unable to accept that spray timing and constituents are not fixed."

Response: The statement referenced in the PHA is an acknowledgement that OHA understands pesticide application timing and constituents are not fixed and that last minute decisions are made based on needs on the ground at the time of application. The statement does not attribute motives to this fluctuation in practices, though it does assume that changes in practices are deliberate, in that they are not accidental.

OHA has not yet reviewed application records from years prior to 2011 or in 2012. OHA does plan to do this analysis as part of the ongoing exposure investigation as described in the Public Health Action Plan section. If the commenter is willing to share their analysis of application records with OHA, this will help expedite the process. ODF is a partner in the exposure investigation and as such, has had multiple opportunities to clarify forest practices and provide input on this report.

Comment 27: "This report fails to address the many potential pathways of exposure and makes the assumption that it is likely caused by spray drift from aerial applications. This conclusion [Conclusion 10 on pages 5 and 55] is not justified by the sample results. The 2011 fall urine samples determined that 92% of the participants had detectable levels of 2, 4-D (of which all were below levels expected to harm people's health) However, the report does not address the fact that 2, 4-D was not aerially applied in this same time period. How can one conclude that the source of exposure is spray drift when 2, 4-D was not even aerially sprayed in the preceding months? Conclusion 9 of the report states there is "insufficient information to confirm that local pesticide applications are the source.... However, available evidence suggests it is possible". Where is this evidence?"

Response: See response to Comment 1 for updates on revisions to Conclusion 9 and the new Conclusion 10. The information referenced in this comment is now addressed in Conclusion 10 of the final report. Conclusion 10 cites the statistically significant increase in spring 2011 urinary atrazine metabolite levels in the nine samples collected within 24 hours of known aerial applications of 2,4-D and atrazine. Given that atrazine is a controlled substance whose use must be reported, these four aerial applications were the most likely sources contributing to the observable increase in urinary atrazine metabolite levels for those nine 24-hour subset samples.

The spring 2011 urine samples had overall generally elevated concentrations of 2,4-D and atrazine metabolites and many of them (13) were collected prior to any known applications for the year. This indicates that additional sources of these pesticides in the community exist that cannot be explained by the application records data available to OHA.

Comment 28: "I think that the PHA should recognize that any rural farming or forestry populations are going to have greater exposure levels than US urban populations to these compounds. If the comparison base was stratified for this bias, I did not see it in the PHA."

Response: The NHANES data used as a representation of the general U.S. population may have an urban bias, however, it is the only dataset available for use as a reference point for the U.S. overall. It is not possible to stratify these data by parameters that would separate urban from rural subpopulations.

Comment 29: "By treating the Highway 36 Investigation as an isolated incident, the PHA fails to assess the overall risk of pesticide exposure and how the increase of that risk is related to Oregon's forestry chemical policy."

Response: OHA understands that many of the climate, topography, and land use patterns at play in the investigation area are not unique in Oregon. However, the State does not have the resources to expand the investigation beyond its current geographical scope.

Comment 30: "We encourage PARC to continue to study the effects of pesticide/ herbicide applications in the forested rural Oregon, making an effort to:

a. include larger sample sizes to gain statistical significance
b. establish adequate scientific measures to test the air
c. obtain accurate chemical applicator records including private applicators
d. investigate research into the impact of pesticide/herbicide impact on human health including research in addition to EPA data, and evidence of the synergistic effect of multiple and chronic chemical exposure for both adults and children
e. study long term health data for residents in rural forested areas"

Responses:

a. OHA currently does not have the resources or capacity to test larger numbers of affected community members
b. EPA is developing methods and equipment for testing air quality relative to ambient pesticide concentrations
c. The records that ODF, ODA, and OHA have requested and reviewed include private chemical applicators. Private applicators are also required to keep application records and supply them when requested.
d. See response to comment 22 and 32
e. A long-term health study is beyond the scope of this exposure investigation. An academic institution would be best suited to seek special funding for and implement a long-term health study.

Comment 31: "On page 23, the PHA states that 'eight of the thirteen known ….pesticide applications that occurred during fall 2011 … used Glyphosate.' However, according to the official spray records obtained by [redacted], there were thirteen instances of Glyphosate use. (See table)"

Response: The referenced statement in the PHA only applies to applications from both forestry and agricultural sources that occurred on the days EPA and DEQ were collecting environmental samples (Sept. 19-22). The referenced table provided by this commenter listed seven forestry applications that occurred outside of the Sept. 19-22 period and did not include two agricultural applications that did occur during that period.

Comment 32: Many commenters attached or provided links to peer-reviewed studies that supported evidence showing low-dose chronic exposure to atrazine can cause harmful health effects. The comments claim these studies and materials indicate that current toxicity thresholds are not protective of public health, especially for children. Based on conclusions of submitted materials, commenters urged OHA to conclude more definitively that the level of exposure documented in Highway 36 Corridor residents has harmed, is harming or will harm their health or the health of their children.

Other comments state that the PHA understated the margins of safety built in to the toxicity threshold values used to evaluate exposures in terms of public health risks.

Response: OHA reviewed the materials submitted by commenters. There is a wide variety in findings, quality, and relevance of materials provided. Some of the materials submitted to OHA consisted of research papers describing effects on wildlife (e.g. frogs), and it is difficult to know how relevant those effects are to human health. Other submitted materials described effects observed in vitro (looking at cells in isolation in a petri dish), and it is difficult to predict how changes seen in vitro will translate into a complex, living human being. Toxicologists use in vitro studies to determine which outcomes to look for in animals or humans. Sometimes those outcomes are found in animals or humans, and often times they are not. Because predictions based on in vitro studies often do not translate into observed changes in animals or people, they cannot be used on their own to support toxicity thresholds. Other submitted articles described epidemiological studies in humans where atrazine exposure was statistically associated with specific health outcomes in humans. This report already references some of those epidemiological studies. EPA and ATSDR have regular review schedules for atrazine. Epidemiological studies published before the last review would have already been considered in existing toxicity threshold values. Epidemiological studies published after the last review will be considered in the next round of review for atrazine.

OHA cannot develop its own threshold values, as the time and cost is prohibitive. OHA relies on the EPA and ATSDR to determine appropriate toxicity threshold values.

Toxicity threshold values represent doses, including large safety margins, of a given chemical below which no human health effects are expected over designated lengths of exposure. EPA has an oral reference dose (RfD) for atrazine (35 µg/kg-day) which applies to chronic exposure over a lifetime and was designed to be protective of sensitive populations including children. ATSDR also has an oral minimal risk level (MRL) for atrazine that applies to acute or short-term exposures lasting less than 2 weeks. This acute MRL is 10 µg/kg-day. ATSDR also has an MRL for oral exposure to atrazine lasting longer than 2 weeks but less than 1 year. This intermediate MRL is 3 µg/kg-day.

One common thread for all of these toxicity thresholds is that they are expressed in terms of an oral dose delivered per kilogram body weight per day. Given that none of the environmental sampling (drinking water, food, soil) for this EI found atrazine at detectable levels, it is impossible to estimate an oral exposure that could be compared against these toxicity thresholds. Community sampling found atrazine metabolites in urine. However, there are no currently available methods (public or peer-reviewed) to estimate an oral exposure that could be compared to these toxicity thresholds based on a concentration in urine. Therefore, OHA is not able to compare measured concentrations of atrazine metabolites in urine against any toxicity thresholds, which would support conclusions about health effects related to the measured atrazine concentrations in urine.

Comment 33: Several comments expressed concern that the toxicity information on 2,4-D and atrazine that the government uses relies too heavily on industry-funded studies. These comments suggest that industry-funded studies could be influenced by a conflict of interest. The argument presented by commenters is that the companies selling these products have a vested financial interest in obtaining study results that indicate that their products are safe so that they can continue to sell them.

Response: While OHA understands and acknowledges this concern, it is beyond the scope of OHA's ability to address it. In addition to industry-funded studies, EPA also considers information provided from other sources such as the findings of researchers at academic and scientific institutions who study the toxicology of pesticides, as long as those studies meet appropriate data quality requirements. ATSDR establishes its MRLs using the same or similar information. To assure impartiality and data quality, the conduct of these studies is subject to strict controls, and there are steep penalties for conduct not in-line with these controls. It is the EPA and not OHA that audits these studies and enforces those controls.

Comment 34: "The PHA fails to address the fact that 2,4-D was detected in urine samples of 92% of the residents tested in fall 2011, despite that fact no 2,4-D was used in forestry or agricultural applications during the fall, with the last reported 2,4-D spray occurring in May 2011. It is unlikely that 92% of the residents used any 2,4-D products in the fall months, particularly since many of the residents do not use any pesticides on their residential property. The PHA should add a discussion as to whether 2,4-D may be more persistent in the environment than previously reported, might have a longer urinary half-life than previously reported, or that 2,4-D exposures might be from residual environmental exposures. The report should make recommendations about future investigations to better understand the fate of 2,4-D in a forestry ecosystem and to understand how the (latent) exposure is occurring."

Response: The fall 2011 urine samples indicate that 2,4-D exposure during that time period were within the expected range for anywhere in the United States. In the most recently released NHANES report, at least 50% of the sampled population had detectable levels of 2,4-D, and the sampled population was skewed towards urban environments where 2,4-D exposure is expected to be lower than in rural environments. OHA expects that the frequency of 2,4-D detection will continue to increase across the country, not so much as a function of increased 2,4-D exposure but rather as a function of chemists' abilities to detect smaller and smaller amounts of 2,4-D. None of the environmental samples collected for the EI (soil, water, food) explain where the urinary 2,4-D in fall 2011 samples came from. Because 2,4-D passes through the body within 24 hours and only lasts a few weeks in soil, 2,4-D would have been expected in soil, water, or food if those were the sources of the 2,4-D in urine.

Comment 35: Several commenters expressed concerns about the validity of community-collected urine samples based on gaps in the chain of custody. The predominant concern is that the gap in the chain of custody could have provided community members opportunity to tamper with their samples by either adding atrazine-containing pesticides to their urine samples after they had been produced or intentionally exposing themselves to atrazine.

Response: The portion of the chain of custody that was missing for some samples did not occur until after samples had been delivered to the loading docks at Emory University. All samples had complete chains of custody from the time the samples were collected at the health clinic until they were shipped from the clinic to Emory University (as explained on page 27 of the report). In order for a community member to have used the existing gap in the chain of custody to tamper with their sample, they would have to have been physically present at Emory University in Atlanta, Georgia when the samples arrived at the loading dock, intercepted them between the time university mail services picked them up from the dock and dropped them off at the researcher's laboratory, resealed the packages, and delivered them to the researcher's laboratory. This scenario is so unlikely that it cannot be viewed as a credible possibility.

Alternatively, participants could have brought pesticides containing atrazine with them into the clinic restroom where they produced their sample and added the pesticides before handing them to clinic staff. This is very unlikely because adding an atrazine-containing pesticide to a urine sample would have resulted in high concentrations of parent atrazine detected in the samples. In fact, no parent atrazine was detected in any of the urine samples. Only DACT and other metabolites of atrazine were detected. This indicates that the parent atrazine had passed through a living body and into the urine samples.

It is possible to purchase the detected atrazine metabolites online, but to add them to the urine samples in the expected ratios, as they were detected, would have required considerable skills in chemistry and sophisticated methods of measurement and the ability to distribute this knowledge to all of the participants. This scenario is extremely unlikely, and it cannot be viewed as a credible possibility.

The participants could have intentionally exposed themselves to atrazine before producing their samples, but no chain of custody or method of sample collection or delivery could have prevented this, including OHA's fall 2011 sampling procedure. Concerns about this method of tampering are separate and distinct from concerns about the chain of custody.

Comment 36: Several comments noted conflicting language in the summary portion of the PHA. The introduction to conclusions related to the question "What health risks are associated with these exposures?" stated "…no levels (of pesticides) expected to cause health effects were documented in this investigation." This statement is inconsistent with conclusion 14 (now 16) which states that "We cannot determine whether the levels of atrazine metabolites measured in Highway 36 investigation area residents' urine in spring 2011 could harm people's health."

Response: OHA updated the introductory language to that section of the summary (see page 7)to be consistent with all of the conclusions in that section.

Comment 37: "The basis of the decision for Conclusion 11 [now Conclusion 12] is misleading. Atrazine or 2,4-D were not detected in drinking water samples taken in fall 2011, most likely because neither chemical was used by the commercial pesticide operators since spring 2011. It is possible that spring sampling would find pesticide detections. Thus, drinking water cannot be eliminated as a potential exposure pathway for future exposures."

Response: The objective of our investigation included the determination of exposure pathways for the 2,4-D and atrazine that was found in the residents' urine. When the sampling protocol was developed, the EI team considered the potential for exposure from drinking water and agreed that it was very important to test the drinking water pathway. There was also agreement among the hydrogeologists on the team that if there were no detections in groundwater, this would likely rule out drinking water as an exposure pathway. The key reason for this is that groundwater chemistry tends to be stable and persistent over time. If the chemicals were infiltrating to groundwater in this area, and were transported to the drinking water sources, there would be detections in at least some of the wells. The drinking water sources tested in the fall of 2011 had no detections of 2,4-D or atrazine. Our conclusion with respect to the drinking water pathway was that it is unlikely that atrazine or 2,4-D could have been present at concentrations high enough to cause the observed urine concentrations in the spring of 2011 and then be low enough to be undetectable by fall of the same year. We apologize for not explaining this in our basis of decision in Conclusion 11 (now Conclusion 12).

OHA modified Conclusion 11 (now Conclusion 12) to specify that the elimination of this exposure pathway applies only to fall 2011 when water sampling was done. OHA also added a new conclusion (Conclusion 13) stating that the concentrations of pesticides in drinking water at other times of year and in other years are unknown. Available pesticide application records do not indicate any applications of 2,4-D or atrazine for several months prior to the first thirteen spring 2011 community-collected urine samples that contained 2,4-D and atrazine metabolites. In the unlikely event that 2,4-D or atrazine were in drinking water at that time, the source is unknown.

Comment 38: "Buried in conclusion number 14 is the following statement, 'The levels of 2,4-D measured in Highway 36 investigation area residents urine in spring and fall of 2011 were 'below levels expected to harm people's health.' Rigorous systems are established to register herbicides for use in the United States. Voluminous data are collected and analyzed prior to setting standards for exposure; in this case biomonitoring equivalents for 2,4-D. This conclusion is the definitive finding of the report. It should be presented as a dominant finding and could be more affirmatively stated, for example, '…below levels determined by the EPA to pose any health risks.'"

Response: OHA and partner agencies approached the EI with a set of guiding questions (page 1). OHA expressed conclusions in the same sequence as the questions they answer. The relative importance of the report's conclusions may vary depending on the audience.

Comment 39: A few commenters suggested that some of the exposure pathways in Table 1 should be listed as "completed" exposure pathways rather than "potential" exposure pathways.

Response: For a pathway to be listed as "complete," all five elements of the pathway (source/release, transport in environment, point of exposure, route of exposure, exposed population) have to be known to exist. In all of the potential pathways listed, there was at least one element of the pathway where there *was no data to confirm or rule-out the pathway. Most often, the missing piece of data was in the "transport in environment (media)" element of the pathway. This means there was a critical data element on pesticides in air, water, or soil missing from the pathway. It is also important to note that a pathway exists for individual pesticides. This means that imazapyr in water and 2,4-D in urine, for example, does not constitute a completed exposure pathway because they are different chemicals. Because there was no environmental (air, water, soil, food) data collected in conjunction with spring 2011 urine samples, it is not possible to determine whether any specific exposure pathway is complete for those samples. Again, this is because, for that time period, there are no data for the "transport in environment (media)" element in the exposure pathway (column 3 in Table 1 page 17).*

Comment 40: "If valid air sampling results are obtained, there should be other exposure information for use in any analysis. [Redacted] suggests that issues with the Interim Report must be resolved to ensure the best available data is used and that sample design problems are identified to substantiate data reported are of maximum quality."

Response: EPA will be the lead agency on method development, study design, and sampling plans for any future air monitoring. OHA will provide input, but will primarily rely on EPA's expertise.

Comment 41: "Because there is evidence of pesticide/herbicide exposure despite a paucity of data, and because the OHA has expressed a sincere interest in the health of the local residents, we feel one conclusion of this investigation should recommend a moratorium on aerial helicopter applications in the area as a precautionary principle to protect the dozens of residents in the area whose subjective reports, alongside PARC's investigation, point to likely airborne pathways of exposure in the process of elimination. The implicit conclusion that aerial pesticide/herbicide applications are benign until a proven pathway if found, given the extensive first-hand experience, initial urine data, and visual evidence of local residents, is biased towards the status quo, and against common sense and a basic human ethic of care."

Response: To recommend a moratorium on aerial applications, we would need to determine that aerial applications were the actual source of exposure. The evidence collected so far indicates that in spring 2011 some residents were exposed to 2,4-D and atrazine at levels that were higher than normal for the general U.S. population. However, the timing of many of the spring 2011 samples collected was before any known aerial applications (see responses to comments 1 and 12). These samples had elevated levels of 2,4-D and atrazine even though they were collected before any known aerial applications. This indicates that aerial applications may not be the major source of atrazine or 2,4-D found in urine samples. With this uncertainty, we must conclude that the data do not support a moratorium on aerial applications.

Comment 42: OHA received several comments with specific suggestions and input about the study design and sampling plans for future air monitoring and other kinds of environmental monitoring in the EI area. Some of the suggestions include numbers of monitors that should be deployed, where they should be deployed, how long they should be deployed for, and who should know when and where monitors are deployed. Some comments provided detailed plans for water and other environmental sampling.

Response: See response to comment 40. OHA has already provided EPA these comments for them to consider as they design future environmental monitoring methods, studies, and sampling plans.

Comment 43: Some comments requested that OHA work directly with legislative counsel to develop a bill that would establish a notification system that would allow residents necessary information about timing and location of pesticide applications to be able to leave the area if desired.

Response: OHA has already recommended that partner agencies that are more directly involved with the regulation of pesticides develop or modify a notification system. OHA intentionally kept the language in the recommendation broad, with the ultimate goal of a functional notification system in mind. It may be that the goal can be achieved more quickly without engaging the legislative process. OHA wanted to avoid designating a specific process by which this goal must be achieved, allowing room for innovation and efficiency. OHA does not have enough experience in pesticide use regulation to confidently recommend a specific process or notification system. OHA is available to partner agencies to consult and inform the process as needed.

Comment 44: Several comments expressed that no amount of exposure to pesticides is acceptable, no matter how small.

Response: Every individual chooses whether a level of exposure is acceptable to them or not. As a public agency, OHA is constrained to make determinations about thresholds of toxicity based on science. The weight of scientific evidence clearly demonstrates that toxicity depends on the dose of a chemical received. Even in the case of endocrine disruptors and other types of chemicals with low-dose effects, evidence still suggests that the dose is important. There is a great deal of public debate occurring about whether current testing programs are adequate to capture potential low-dose effects, but most scientists still agree that there is some dose below which no harmful health effects are likely to occur. The reality of life in the developed world is that exposure to chemicals at some level is unavoidable, and as chemists improve their ability to detect lower and lower concentrations of chemicals in the environment we expect to find chemicals where previously we could not.

Comment 45: Several comments expressed concern about the cost of the EI in light of the lack of clear findings of harm to public health. These comments request that the EI be discontinued.

Response: One critical exposure pathway, air, has not yet been fully characterized. It is important to continue the EI until we have a clear picture of the potential for people to be exposed to pesticides via air, from either drift or re-volatilization. The EPA is in the lead of future work on the EI related to air monitoring. OHA will be available to consult and inform EPA's process, but this involvement is not likely to be extensive or costly to the state. OHA has also committed to analyze pesticide application record data from 2009 and 2010 to document trends in application practices over time and to determine whether conditions in 2011 were representative of typical years. OHA will present the results of this analysis along with (i.e. at the same time as) results from EPA's air monitoring.

Comment 46: Several comments expressed concern that additional sampling is needed and that the EI would be discontinued too soon.

Response: See response to 45.

Comment 47: Several comments requested buffer zones around residences and schools where no aerial pesticide applications would be allowed. Suggested buffer zones varied in distance from schools and residences and in the permanence or duration of the use of buffer zones. Some wanted permanent buffer zones, while some wanted temporary buffer zones until air movement from application sites is better understood.

Response: OHA created a new recommendation (page 11) to partner agencies to continue to collaborate to develop best practices to reduce exposures to people in the community. Buffer zones may be one of multiple options to address this recommendation.

Comment 48: Several comments suggested that OHA, "Complete a thorough analysis of the pesticide data using spray records data from 2009 through 2013. Look for trends and examine the forestry pesticide practices and human health and environmental data to determine the source of pesticides exposures."

Response: As stated in the response to comment 13, OHA did not have the resources to enter and analyze records from 2009-2010 for this report, but it is on the Public Health Action Plan for additional work on the EI. That additional analysis will be done and released in coordination with additional air monitoring work the EPA is planning. Also, see response to comment 26.

Comment 49: There were several comments that were similar to this one asking OHA to "Perform air sampling and monitoring, and test for biomarkers in accordance with the seasonal cycles of forestry pesticide spray. [Redacted] has analyzed the seasonal trends and found that Atrazine, 2,4-D, Clopyralid and Hexazinone are typically used in the spring. Glyphosate, Imazapyr, Triclopyr, Metsulfuron methyl and Sulfometuron methyl are typically used in the summer and fall. Fall urine samples should be analyzed for Glyphosate."

Response: Additional air monitoring is in the methods development and planning phases (see response to comment 45 and 26). The second paragraph of the "Suspension of Spring 2012 Sampling" section on page 26 of the report highlights the logistical challenges of additional urine sampling timed to pesticide applications. These challenges make additional urine sampling unfeasible for OHA. While many environmental laboratories have the technical capacity to test for additional pesticides in liquid media, they often lack the necessary accreditation to handle human biological samples. Conversely, public health laboratories that have the accreditation to handle human biological samples often lack the equipment to test for pesticides. The laboratory at the National Center for Environmental Health (NCEH) in Atlanta, GA is one laboratory with the capacity to do both. However, they do not have methods in place to test for glyphosate or any of the other pesticides mentioned in the comment. California and Washington States both have some capacity to test for pesticides in biological samples, but for the most part they house the same methods used at the lab in the NCEH to ensure that their results can be compared against NCEH's reference populations (NHANES). Another challenge to testing for additional pesticides in urine highlighted on page 26 of the report is that having results with nothing to compare them with would have little meaning. Without some reference population or toxicity value, it would be impossible to determine whether measured results (if detected) were high or low compared to other people in the United States or compared against toxicity thresholds. Also, see responses to comment 13 and 45 regarding additional analysis of pesticide application records.

Comment 50: "Detection of pesticides in residents' urine samples indicates the probability that pesticide applications violate registered product labels and present a heightened drift risk. [Redacted] recommends that the Investigation Team undertake a thorough investigation of aerial forestry spray practices, including height of aerial craft at time of spray, weather, wind, temperature, droplet size, pesticide product, tank mixing and the use of adjuvants."

Response: Detection of pesticides in resident's urine does not necessarily indicate that a registered label violation has occurred. Numerous studies of applicators and their families have routinely found detectable concentrations of pesticides in their urine even when applicators carefully follow label instructions. OHA relies on ODA and ODF to ensure that pesticides in Oregon are applied according to the labels.

Comment 51: One commenter recommended that OHA:
"1. Obtain spray records for 2009-2013.
2. Ascertain why there have been increases in
   a. Number of spray applications
   b. Pounds of pesticide applied
   c. Increase in the pesticide products sprayed
   d. Increase in the pounds applied per acre
3. Fill in the data gaps to evaluate how repeated applications, tank mixes, adjuvants and aerial spray may increase risk to public health.
4. Use different ways to evaluate the spray data for environmental toxicity and impacts to public health. RfDs and BEs are narrow ways to view the data; we recommend a systems approach.
5. Evaluate individual practices of the timber operators and make recommendations to develop policies that ensure the safest practices that will protect nearby communities from aerial drift and exposure to 2,4-D and Atrazine."

Response:
1. See responses to comments 13 and 45
2. Items under recommendation 2 are beyond the scope of the current report
3. These questions are beyond the scope of the current EI and require research budgets not available to the EI team.
4. Environmental toxicity is beyond the scope of OHA's expertise and involvement in the EI. Developing a new method to evaluate human toxicity of pesticides beyond RfDs and BEs is an extremely time and resource intensive process that is beyond the capability of the EI team.
5. Continued work on the EI may help to reach some of the goals in this recommendation. Recommendations in the report itself are designed to protect nearby communities and obtain additional information needed to assess the health risk of area pesticide application practices.

Comment 52: Several commenters stated that they have used various pesticides including 2,4-D and atrazine for many years and have never seen any ill health effects as a result in themselves, their families, or their friends as a result.

Response: Individual experiences or anecdotal information can be helpful in identifying areas for further study. However, without systematic measurement, such information is not usually sufficient to draw conclusions about the burden of disease in a community.

Comment 53: A few comments stated that the report is fatally biased and flawed and should be rewritten or not published

Response: OHA acknowledges that no report can please all readers. All comments are valued and recorded.

Comment 54: A few comments asked for a spray drift study in the Highway 36 Corridor.

Response: EPA is developing plans for future air monitoring to determine concentrations of pesticides in air over a few weeks at a time that span one or more aerial applications. This is not a drift study per se, but will be useful information to help answer questions about human exposure.

Comment 55: Several comments accused state and federal regulators and state and local elected officials of allowing pro-pesticide lobby and trade associations to unduly influence their decisions in regulating how pesticides are used in Oregon and in thwarting efforts to complete originally planned sampling in the spring of 2012.

Response: This comment has been noted.

Comment 56: Some comments accused individual staff on the EI team of demonstrating bias in interactions with community members and in the report.

Response: This comment has been noted.

Comment 57: Some comments stated that atrazine should be banned in the United States as it is in the European Union.

Response: Banning any particular pesticide is beyond the scope of this EI and national policy is beyond the scope of OHA's authority.

Comment 58: "The Oregon Forest Practices Act is a 40 year old policy and is ineffective in protecting rural communities from the impacts of forestry operations for their homes, schools, gardens, drinking water and other activities; the OFPA fails to monitor pesticide applications and the environmental fate of these chemicals, fails to ensure that any aerial practice does not exceed the product label recommended maximum height of ten feet which is used by the EPA to assess drift risk off-site drift; does not address weather, slope, wind direction and swath adjustment for moving wind and fog; and does not address deposition, run-off and chemical-laden sediment in streams."

Response: The Forest Practices Act is the result of state legislation, and as such, it would require legislative action to change it. OHA encourages citizens to work with their elected officials to address concerns about this or any other state law.

Comment 59: "Legal Responsibilities and Rights – Though it may be outside of the scope of your study, I feel that it would strengthen the assessment of a section was added that clearly outlined both the specific responsibilities that state agencies and leaders have for monitoring, analyzing, and regulating use of chemicals in Oregon forests, and the rights of Oregonian related to use of chemicals in Oregon forests. I would assume that this would include such things as my right, as a forest owner, to use chemicals, and the right of my neighbor not to be poisoned by the chemicals that I use. One role of government is to sort out how best to balance these two rights. Your assessment would be more helpful if it both highlighted these types of tensions and explained how we currently resolve the tensions between these two rights."

Response: A summary of legal authorities regulating pesticide use in forest practice and the agencies responsible for administering those laws is outside the scope of this report but has been posted to OHA's website at:
http://public.health.oregon.gov/HealthyEnvironments/TrackingAssessment/EnvironmentalHealthAssessment/Hwy36/Documents/Oregon%20Regulations%20on%20Pesticide%20Applications_final.pdf

Comment 60: "[Redacted] suggests that the final report reference the Washington Forest Practices Act as a viable model for policy changes that would:
1. Align forest practices in neighboring states;
2. Create consistency for timber operators who have operations in both Washington and Oregon, and have a history of compliance with the Washington Forest Practices Act;
3. Promote monitoring and metrics, two aspects of developing good science and reliable data;
4. Provide a blueprint to update the 40-year-old Oregon Forest Practices Act to reflect new information about health and environmental harms associated with pesticide use.
5. Provide the suggested notification of upcoming pesticide sprays that are necessary for rural communities who seek to protect their families, their home grown food and their property."

Response: See response to comment 59. For a comparison of aerial pesticide application practices in the Pacific Northwest see the analysis written by EPA's Region 10 office here:
http://public.health.oregon.gov/HealthyEnvironments/TrackingAssessment/EnvironmentalHealthAssessment/Hwy36/Documents/Oregon%20Regulations%20on%20Pesticide%20Applications_final.pdf

Comment 61: "The basis of the decision for Conclusions 19 and 20 (now Conclusions 21 and 22) are misleading. We observe that a great deal of frustration and friction arises from the lack of credible and meaningful response from state agencies and the Board of Forestry. The community needs a response from the government that respects citizens' rights not to be poisoned and eliminates pesticide exposure from chemical trespass."

Response: OHA received and responded to several similar comments (see below) and revised Conclusion 19 (now Conclusion 21) to broaden the language to include frustrations other than those existing among and between community members.

Comment 62: "While understanding that divisiveness is not healthy for any local community, and many expressions of local distress have been disrespectful and counterproductive, we'd like the PARC team to recognize that their actions also serve a role in the system, and being "neutral scientists" does not exempt the group from impacting the conflict and potentially further polarizing the community. In particular, we would like PARC to:

- respond with more concern to those most vulnerable and expressing distress – this includes validating subjective experience rather than invalidating this experience as untrue until proven by research to be otherwise
- holding an appropriate empathetic presence to those whose lives have been seriously impacted by events described to the PARC team
- allow residents to speak directly to the PARC team in any future meetings rather than have the community "speak to one another," an action which appears self-protective rather than productive. It is also obfuscating to communicate details of the investigation and government agency intricacies beyond the interest and understanding of most participants, rather than distill this information in an appropriate manner in order to open the discussion in a more constructive manner.
- avoid advice that can sound patronizing, and assessment that local conflict can be reduced to "property rights issues" or "different values." All people value health – this is not up for question. When encountering hostility, anger or lack of trust, it may be useful to look into the ways in which they are also a response to the way in which the public agencies have failed to protect public health in the past despite the good intentions of this current PARC team. While not conducive mindsets to positive change, we feel it is inappropriate to blame local residents for poor behavior on top of their original and long standing complaint and to reduce this very serious environmental issues to lifestyle preferences."

Response: Thank you for your comments and suggestions; we will consider them in our future efforts with the investigation. The community concerns section of the report (pp. 40) is where we describe people's subjective experiences more fully, and hopefully, more meaningfully.

Comment 63: "In regard to the section of your preliminary report that addressed internal community relations and, in your opinion, the value of a mediator, we hereby agree but with one key difference: The mediation process would be valuable but the participants in the mediation should be between industry reps and those community members that feel have been harmed by their practices. I – the lead petitioner to the EPA – have never once had any problem with a local farmer or any other community member."

Response: OHA recognizes that formal mediation is one approach among many that could help reduce community stress and improve well-being. If all parties are receptive to the idea stated in the comment, then community leaders, formal leaders (i.e. elected officials), or others in a leadership role can take an active role in initiating that process.

Identifying leadership to spearhead the effort is a critical first step. In the event the community would like to look into professional mediators, here are a few resources to consider. OHA does not have experience with any of these resources and cannot recommend one over the other:

- *The Center for Dialogue & Resolution (formerly Community Mediation Services): www.communitymediationservices.com Phone: (541) 344-5366*
- *The Oregon Mediation Association: www.omediate.org Phone: 503-872-9775*
- *Linn-Benton Mediation Services: 541-928-5323*
- *Your Community Mediators of Yamhill County: http://www.ycmediators.org/ Phone: 503-435-2835*

- *Six Rivers Community Mediation (has an agriculture disputes program): http://www.6rivers.org/community-mediation.html Phone: 541-386-1283*
- *Oregon Solutions: www.oregonsolutions.org/about/contact-us phone: 503-725-9092*

Comment 64: Several commenters felt that the agencies involved in the investigation should increase their knowledge of environmental justice (EJ) issues and establish EJ-related goals for the remainder of the investigation. One commenter felt that the community was denied meaningful public input and instead was blamed for the conflicts and dysfunction. From their viewpoint, this constituted "a violation of EJ principles". This commenter also recommended that the federal agencies on the Investigation Team set a goal of complying with the 1994 Presidential Executive Order 12898 on Environmental Justice.

Response: EPA defines environmental justice (EJ) as "the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies."

OHA is dedicated to the principles of environmental justice. OHA has worked throughout the EI process to incorporate input from Highway 36 Corridor community members who have provided a broad range of viewpoints. OHA's efforts to solicit and incorporate meaningful input from the community have included:

- *Engaging in multiple phone conversations, in-person conversations, emails and listserv updates to and from community members;*
- *Coordinating and hosting three large community meetings that included significant portions dedicated to listening to the community, with input from the community on how that was accomplished;*
- *Coordinating an open house with all involved agencies, as an opportunity for community members to ask questions of and give feedback to the investigation team;*
- *Coordinating a data-sharing open house with community members to share community-collected environmental data and give permission for OHA to include the community-collected urine samples for consideration to be included in the report;*
- *Participating in a community-led conference call with a professor of biochemistry & molecular biology about endocrine disruptors (at the request of community members);*
- *Incorporating and analyzing community-collected air, water and urine data into the report;*
- *Sending out mass mailings, distributing surveys and seeking input on community engagement approaches;*
- *Responding to requests for information, reading literature submitted by community members;*
- *Securing and documenting the chain of custody for the community collected urine samples in order for them to be included in the report;*
- *Soliciting, describing and documenting community concerns; and*
- *Continuing to be a source of information, updates, outreach, and resources*

It is OHA's intention to engage with community members in a meaningful way and support partner agencies to do the same in any future activities related to this investigation.

Comment 65: "The draft report contains two conclusions regarding community conflict over the issue of pesticide use in the study area. In my opinion, this is what is popularly called a "red herring" designed to distract attention from the fact that stress in the study area has resulted from the abject failure of Oregon's state agencies to responsibly address the concerns of study area residents for up to seven years before this investigation began. While I believe that the OHA staff who are participating in this investigation are approaching their work professionally and responsibly, there is no doubt that the residents of the study area have been ignored, insulted, and treated badly for many years by the Oregon Departments of Forestry and Agriculture, as well as the multi-agency Pesticide Analytical and Response Center (PARC)… I saw first-hand how individuals who complained about pesticides to state agencies were ignored, vilified, and demonized by staff from ODA and ODF in particular. It is the nature of regulatory agencies in this country to develop strong ties with the regulated community, and in this case, those ties have interfered with the ability of ODA and ODF in particular to appropriately respond to community concerns regarding potential ill effects from pesticides."

Response: We understand that concerns have been ongoing for many years. Identifying safety concerns is one of public health's roles when working with communities, and OHA is concerned that underlying animosities could result in property damage, personal injuries or worse. We have identified personal safety, mistrust of government and inadequate protection of public health as explicit community concerns that were reported directly to us. Conclusions 19 & 20 (now 21 and 22) were not intended to distract attention from public agencies' responsibilities, but rather to highlight a significant finding of concern.

Comment 66: "The following statement is taken from page iii of the draft report:
"The Highway 36 Corridor EI is a multi-agency effort to respond to several community members' requests to investigate possible exposures to pesticides and herbicides used in applications in the Highway 36 corridor." In fact, the impetus for this investigation was not the requests of community members to investigate possible exposure to pesticides and herbicides; it was the testimony of a national expert in pesticide exposure that residents' urine tested positive for 2,4-D and atrazine, at levels higher than found in the general population. Requests by residents for investigation were routinely ignored by state agencies for years, and it was only when exposure was already documented by urine testing that the state took notice. With all due respect, I suggest that starting out this report with such an obviously self-serving statement that stretches the truth will do little to add to the report's credibility. It would be refreshing, indeed, if the authors would acknowledge the truth—that it was only after pesticide exposure had been documented by urine tests from an acknowledged national expert that state officials took any action at all."

Response: This comment has been noted. OHA added language in the report's forward that more explicitly describes how the EI was initiated.

Comment 67: Some comments expressed concern that the recommendation to improve notification of neighbors about impending forestry pesticide applications places the burden on citizens to protect their health and their children's health (e.g. by leaving their homes for a time) rather than controlling the source of the pesticides.

Comments expressed that state and federal agencies should not allow aerial pesticide applications at all, claiming that it is a human right to not be exposed to hazardous chemicals that have trespassed onto their own private property or public property where they may be exposed.

Response: While OHA recognizes that many people are dissatisfied with pesticide application practices and regulation of pesticide use in Oregon, the Oregon Forest Practices Act (FPA) regulates pesticide use in Oregon's state and private forests. ODF is the state agency responsible for administering the FPA. ODF responded to this comment, "The FPA directs the Oregon Board of Forestry to adopt administrative rules to encourage economically efficient forest practices consistent with natural resource protection. Under the authority of the FPA, the Board has adopted the Chemical and Other Petroleum Product Rules regulating pesticide use on private and non-federal public forestland. The Oregon Department of Forestry administers the FPA and associated administrative rules, but neither the Board nor the Department has the authority to ban pesticide use to protect human health, as long as federal and other state laws allow the uses. If there are monitoring or research findings indicating that current forest practices for pesticide applications result in quantities in soil, air or waters of the state that are injurious to water quality or the overall maintenance of terrestrial wildlife or aquatic life, the board may consider the need for forest practice rule changes. The Board intends that that the FPA and administrative rules work together with federal regulations (U.S. EPA's product registration and labeling requirements) and other state regulations (Oregon Department of Agriculture's Pesticide Control Law) in an integrated pesticide regulatory framework that protects human life, health and property, and the environment. Citizens who believe changes are needed in the FPA may contact their state elected officials to talk about their concerns."

For more information about how pesticide use is regulated in Oregon, see the summary on OHA's website here:
http://public.health.oregon.gov/HealthyEnvironments/TrackingAssessment/EnvironmentalHealthAssessment/Hwy36/Documents/Oregon%20Regulations%20on%20Pesticide%20Applications_final.pdf

Comment 68: "My over-all observation is that if one detects a few parts per trillion in urine, and that this detection differs slightly or not at all from the general population, *there is no possibility of identifying the source, and that the exposures are trivial and low priorities for investigations* (italicized emphasis part of original comment as received). This should have been a guiding principle in this investigation as soon as the first evidence of urine samples had been evaluated."

Response: This comment has been noted. Urine concentrations in the investigation area have been measured in the parts per billion range, not parts per trillion. The EI was initiated not only in response to measured urine concentrations but also in in response to community requests.

Comment 69: "Holistic vs. Reductionistic [sic] Assessments - Though I understand that the nature of the division of responsibilities between state agencies presents challenges in doing this, I feel strongly that future research into the impacts of chemical use in Oregon forests should use a holistic and integrated approach by investigating the impacts on all of the major living communities in the study are – human and more than human. Continuing to do research in isolated silos compromises our collective success in fulfilling our responsibilities to accurately understand the impacts of chemical use across the landscape."

Response: This comment has been noted. While OHA's focus in the EI and on this report is human health, OHA has collaborated with agency partners such as DEQ, ODA, ODF, EPA, and ATSDR throughout the process. OHA is keenly aware that the natural environment and human health are linked, and OHA collaborates with other agencies to ensure that this connection is understood.

Comment 70: One commenter pointed out that the investigation has not analyzed the urine of individuals living within a few hundred feet of aerial sprays, and that participants in the Exposure Investigation lived miles from known applications. The commenter stated that no samples were collected on the same day of exposure, and that those participating in the community-collected urine sampling lived an average of 1.5 miles away from spraying activity and that OHA has not and cannot comment on the level of harm to those living within a few hundred feet of aerial sprays.

Response: All scientific studies are limited in their conclusions by the data collected. One of the areas in which this EI is limited is that data only exists for the individuals that participated in the investigation. There may have been residents living closer to pesticide applications than those participating in the EI, but without data, OHA is unable to support conclusions on how those individuals may have been affected by pesticide applications.

Appendix B: Application Records

OHA requested 2009-2011 application records from ODA and ODF in October 2011 and received most of the application records in June 2012. This section describes OHA's analysis of 2011 application records.

2011 Application Records: Descriptive Statistics

There were 161 reported pesticide applications in the Highway 36 investigation area during 2011. Forty-one (25%) of these 161 reported applications were only reported to ODA, and 120(75%) applications were reported to ODF. Based on OHA's interpretation of the data, 10 (6%) of the 161 applications were for agricultural purposes (e.g., applications on Christmas tree farms and pastureland), 133 (82%) were for forestry operations, and 18 (11%) were roadside applications. Table B1 shows a breakdown of the 2011 application data by these three major "sectors".

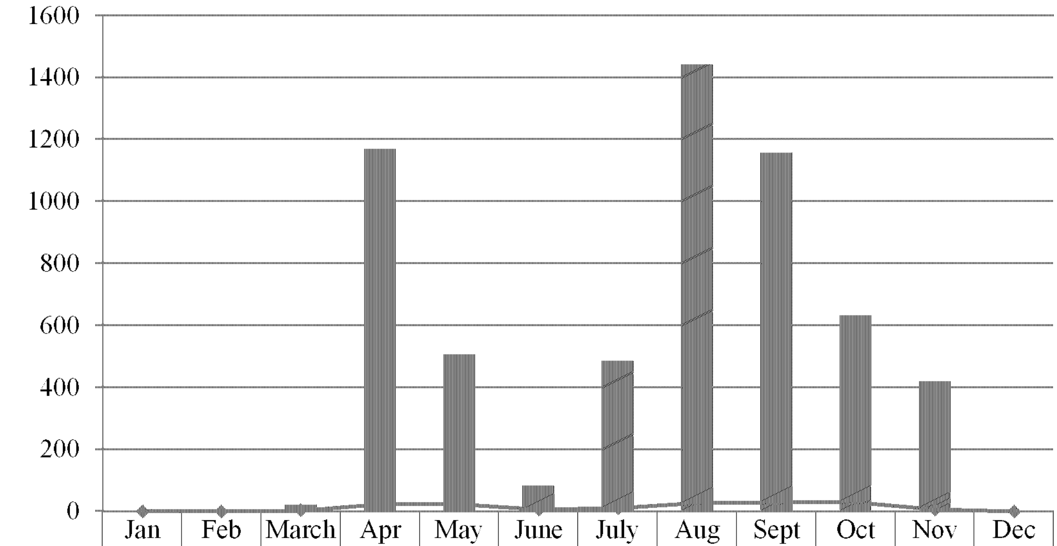
Table B 1: 2011 application data by sector

	Agricultural	Forestry	Roadside	Total
Applications	10 (6%)	133 (82%)	18 (11%)	161 (100%)
Acres Treated	90 (2%)	5,750 (97%)	83 (1%)	5,923 (100%)
Amount pesticides applied (gallons)	128.6 (6%)	2043.5 (92%)	53.5 (2%)	2225.6 (100%)
Amount pesticides applied (pounds)	60.0 (4%)	1345.9 (96%)	0.0 (0%)	1405.9 (100%)

% = percent
Percentages do not add up to 100% because of rounding

There were no applications in January and February, and three applications on 22 acres of land at the end of March (Figure B1). There were 23 applications on 1,171 acres in April, and 24 applications on 508 acres in May. There were few applications in June, 11 applications on 486 acres in July, and 27 applications on 1,442 acres in August. There were 29 applications on 1,157 acres in September, 30 applications in October on 632 acres, and seven applications in November on 414 acres. There were no applications in December 2011. See Figure B1 below.

Figure B 1: Applications and acres treated in 2011 by month.*



	Jan	Feb	March	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Acres Treated	0	0	22	1170.5	508	84.3	485.5	1442	1157.3	632.4	421	0
Applications	0	0	3	23	24	7	11	27	29	30	7	0

* Note: Two applications in March, one application in June and one application in July were missing data on acres treated.

Aerial applications accounted for 23% of 2011 applications, and roughly 37% of acres in the investigation area were treated with this method (Table B2). Approximately 22% of applications were hack and squirt treatments (34% of acres), 11% of applications were roadside applications, and approximately 27% of applications were ground-based treatments (18% of acres).

Table B 2: Application methods for 2011 pesticide applications in investigation area.*

Application Method	Number of Applications	Acres Treated
Aerial	37 (23%)	2198.5 (37%)
Ground	44 (27%)	1045.2 (18%)
Roadside	18 (11%)	82.8 (1%)
Hack and Squirt	35 (22%)	2022.0 (34%)
Unknown	27 (17%)	574.5 (10%)
Total	161 (100%)	5923.0 (100%)
*Note: We inferred application method for six aerial applications, three ground applications and two roadside applications. % = Percent. Percentages do not add up to 100% because of rounding.		

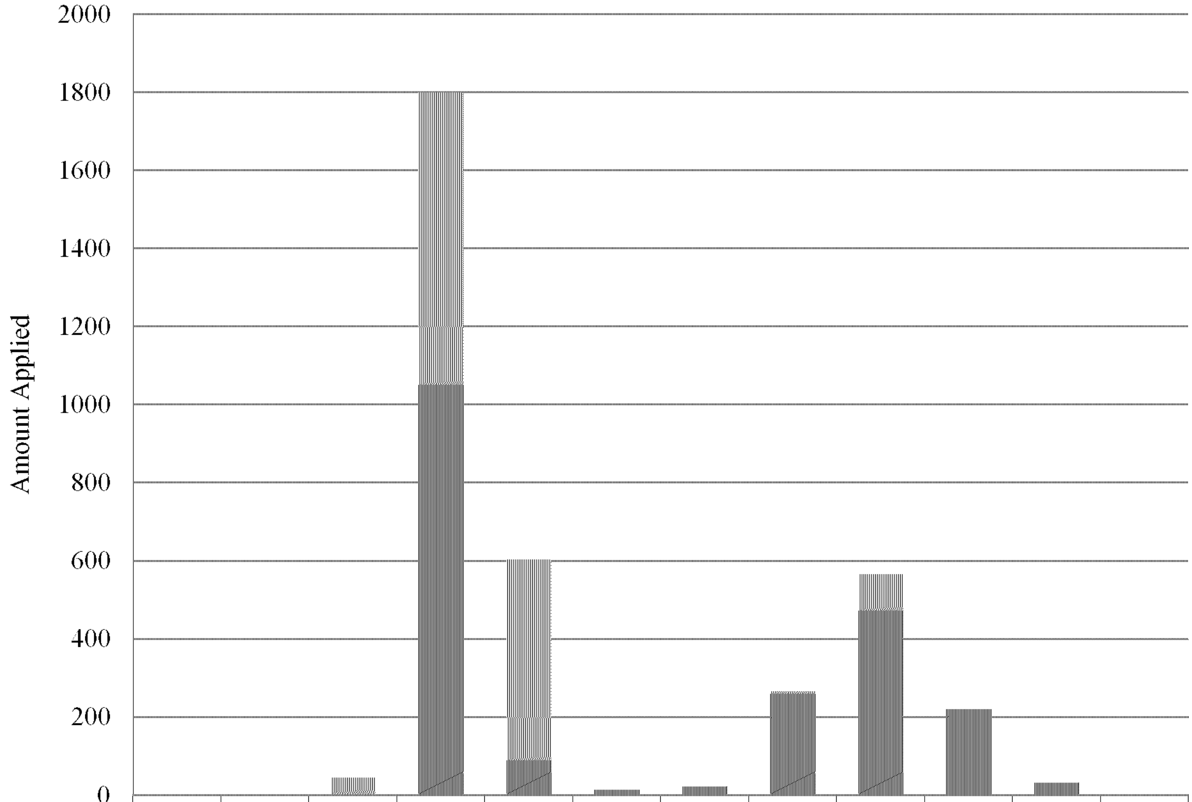
During 2011, an estimated 2,168 gallons of liquid pesticides and 1,406 pounds of dry pesticides[20] were applied in the investigation area (Figure B2). There were ten pesticides (not including adjuvants)

[20] These are estimates of pesticides in liquid and dry form before they were mixed with water, surfactants and other additives.

applied in the same area in 2011: 2,4-D, aminopyralid, atrazine, clopyralid, glyphosate, hexazinone, imazapyr, metsulfuron methyl, sulfometuron methyl, and triclopyr. Pesticide amounts were reported as a mixture of pounds and gallons. It is possible to convert gallons to pounds, but OHA did not have the time resources to make those conversions for this report. Without making this conversion, it is not possible to rank pesticides by overall amount applied. The pesticides used were: hexazinone (1,304 lbs/50 gallons), glyphosate (710 gallons), atrazine (702 gallons), 2,4-D (345 gallons) and imazapyr (252 gallons). 2,4-D, atrazine, clopyralid, and hexazinone were used exclusively during during the early part of the year (April and May), while imazapyr, metsulfuron methyl, and sulfometuron methyl were used predominantly in late summer and fall applications (Table B3).

In the investigation area, the township ranges with the most pesticide applications and largest number of acres treated were 16S 06W and 16S 07W (Figure B3). The township ranges with fewest applications (and fewer acres treated) were 16S 08W and 17S 07W.

Figure B 2: Amounts of pesticide products applied in 2011 by month.*



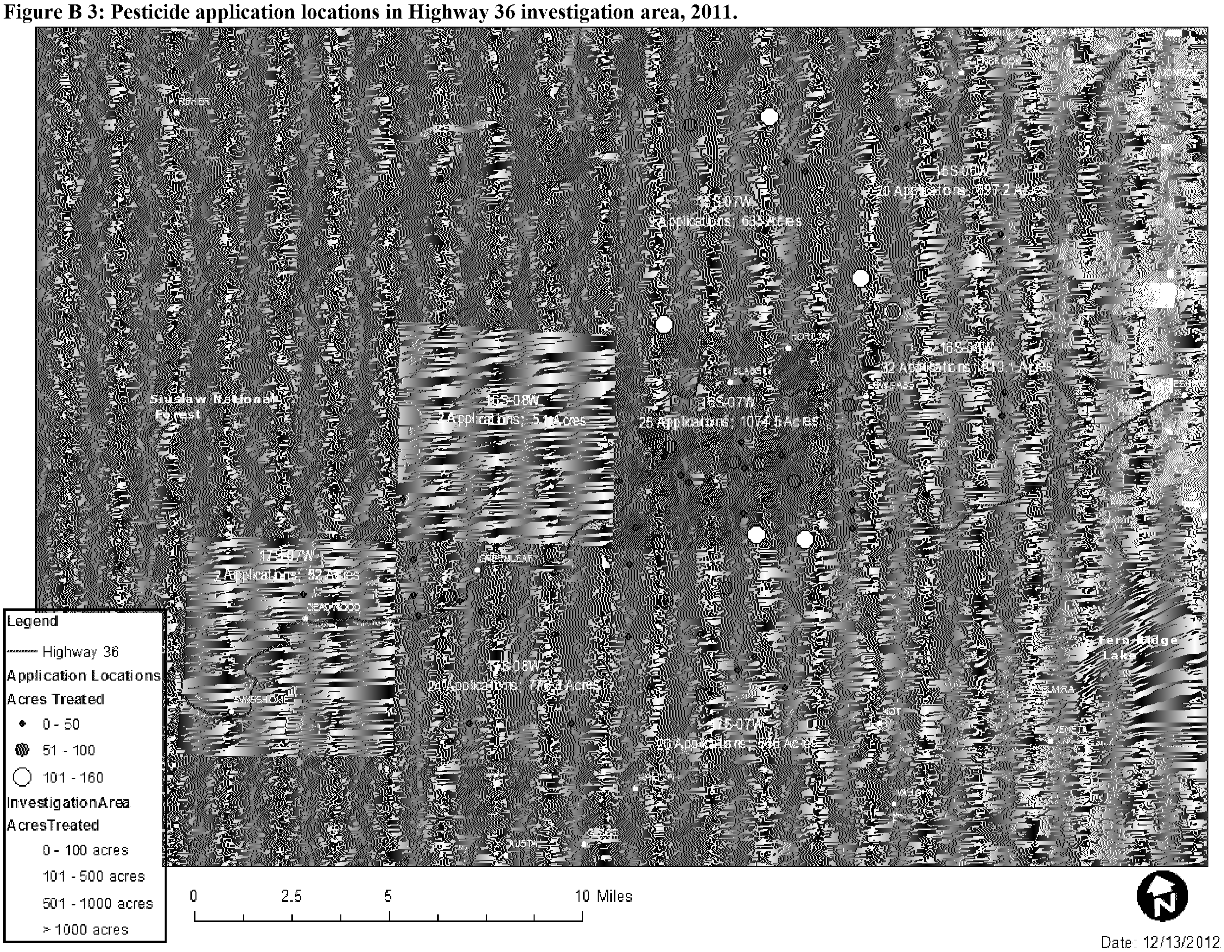
	Jan	Feb	March	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Pounds	0.0	0.0	44.0	747.8	514.5	0.0	0.0	5.8	93.9	0.0	0.0	0.0
Gallons	0.0	0.0	1.1	1051.5	90.0	14.1	23.4	261.0	473.4	220.5	33.0	0.0

* Note: The amount applied does not include adjuvants or carriers (e.g., water, surfactants, and dyes). Two applications (one in March, one in August) were missing data indicating the amount applied.

Table B 3: Amount of pesticides applied in 2011 by month (darker shading indicates larger amounts).

Active Ingredient	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Total
2,4-D (gal)		325.4	20.0							345.4
Aminopyralid (gal)		1.5			0.6	2.7	0.5			5.3
Aminopyralid, Triclopyr (gal)			5.1	1.2	1.5					7.8
Atrazine (gal)		672.6	29.0							701.6
Clopyralid (gal)		10.8	2.1							12.9
Glyphosate (gal)	1.0	2.5	22.0	12.8	16.5	202.4	330.9	167.5	2.6	709.5
Hexazinone (gal)		38.6	11.2							49.8
Hexazinone (lbs)	44.0	745.8	514.2							1304.0
Imazapyr (gal)			0.3		3.8	48.6	140.4	44.9	30.4	251.5
Metsulfuron methyl (gal)						0.1	0.9	0.2		1.3
Metsulfuron methyl (lbs)						5.8	22.6			28.3
Sulfometuron Methyl (gal)	0.1					3.8	0.6	4.0		8.6
Sulfometuron Methyl (lbs)		2.0	0.4							2.3
Sulfometuron methyl, Metsulfuron methyl (gal)						3.3		3.8	0.2	3.3
Sulfometuron methyl, Metsulfuron methyl(lbs)							71.3			71.3
Triclopyr (gal)			0.8	1.3	21.8	24.6	8.6	0.8		57.5
Total (gal)	1.1	1051.5	90.5	15.3	45.2	285.5	482.0	221.2	33.2	2225.6
Total (lbs)	44.0	747.8	514.5	0.0	0.0	5.8	93.9	0.0	0.0	1405.9
*Notes: Excludes carriers and adjuvants. One application of glyphosate and sulfometuron methyl in March, and one application of glyphosate and triclopyr in August were missing data on the amount applied. Gal = gallons; lbs = pounds.										

Figure B 3: Pesticide application locations in Highway 36 investigation area, 2011.



ED467-000036651 EPA-6822_038704

Data Processing and Analysis
The ODA and ODF application data were processed in Excel and SAS to obtain a single dataset of 2011 pesticide applications in the Highway 36 investigation area. The final merged dataset had data on 161 applications (Table B4). SAS was used to obtain basic descriptive statistics (e.g., number of applications per month, acres treated) for the pesticide application data.

Table B 4: Number of records and applications in 2011 dataset.

	ODA Records	ODF Records
Files	-	88
Total Observations (Rows)	165	324
Number applications	100	120
ODA applications not in ODF dataset	41	
Total applications	161	
ODF – Oregon Department of Forestry; ODA = Oregon Department of Agriculture		

ODF Records Data Entry

OHA staff abstracted all available ODF records for 2011. Data were abstracted into an Excel spreadsheet. Table B5 shows the fields abstracted from the records. One OHA staff member abstracted records from January – July 2011, and another OHA staff member abstracted records from August – December 2011.

Table B 5: Data fields abstracted from ODF records.

Data Field	Notes
Notification and Unit Number	-Indicates the corresponding ODF notification number
Application Date	-Date of application. Some records had more than one date on the record. If the record indicated the amount of chemicals applied on each date, we entered each date as a unique application. If the record provided the total amount of chemicals applied over several dates, we treated the record as a single application, and entered multiple dates/times in the appropriate cells.
Project Name	Name of treated unit
Landowner, Operator, Contractor	The Landowner and Contractor fields were abstracted from records; the operator field was populated based on information on ODF's SharePoint site.
Township, Range and Section	Township-Range-Section location of treated unit. If the area spanned multiple sections, we entered all sections separated by commas (e.g., 10, 12, 14).
Longitude, Latitude	Many records did not have latitude/longitude indicated. For these records, we estimated coordinates using the following process: 1) If the record (or corresponding notification) included a map of the unit, we visually identified the unit using ArcGIS, and used the rough center point of the unit for longitude/latitude coordinates. 2) If no map was available, we used the coordinates of the center point of

Data Field	Notes
	T/R-Section in which the unit was located. Note: Used GCS_NA_1983 coordinate system
Other location	Not standard across records; may drop this field. Some records indicated elevation (entered as E:XXXX). A few applications occurred in Benton County, but within our investigation area.
Acres	Most records indicated the number of acres treated, though a few records of roadside treatments indicated miles instead of acres.
Chemical Supplier	Entered company indicated on record; left blank if not indicated.
Product Name and Registration Number	Chemical name and EPA registration number. In some cases, the product name and registration number did not match up. In these cases, we crosschecked the information with ODA application records, or used our professional judgment to enter the correct product name and corresponding registration number. In addition to registered products, we entered data on adjuvants (e.g., surfactants, dyes).
Active Ingredient	Identified from EPA product labels
Product Application Rate	In most cases, we entered the product application rate as indicated on the record. If the rate was not provided on the ODF record, but provided in a corresponding ODA record, we entered the ODA application rate. In some cases, we back calculated the rate by dividing the total amount applied by acres.
Product Total	Total product applied during the application. If the total was not provided on the record, we calculated the total amount by multiplying the application rate by number of acres.
Carrier	Product carrier used during application
Carrier Rate	Product carrier rate. In some cases, we back calculated the rate by dividing the total amount applied by acres, or estimated the rate based on the percentages provided on the record.
Carrier Total	If the total was not provided on the record, we calculated the total amount by multiplying the application rate by number of acres, or estimated the total based on the percentages provided on the record.
Start Time and End Time	The start and end time indicated on the application record.
Total Rate and Total Applied	The total amount of product(s) and carrier applied during an application. If not indicated on the record, we calculated this field based on product and carrier rates/totals.
Application Type	This information was not indicated on some records. In some cases, we inferred application type based on other information on the record (e.g., equipment used, meteorological data).
Meteorological Information	We entered the time of measurement, temperature, humidity, wind speed, and wind direction for up to 4 meteorological readings. A few records (with multiple application dates) had more than 4 readings; for these, we entered the first four readings.
Planting Date	Date/Year unit was planted; rarely indicated on record, may drop this field.
Target Species	Species targeted during application.
Equipment Used	Equipment used for application; sometimes method was indicated (e.g., hack and squirt)

Data Field	Notes
ODF – Oregon Department of Forestry; T = Township; R = Range; EPA = Environmental Protection Agency; ODA = Oregon Department of Agriculture	

Data Quality Check
To ensure the data were abstracted correctly, all data entries were checked against the actual application record by OHA staff. In addition, ODF conducted a 10% check of abstracted records.

ODA Records Acquisition and Data Quality Control
The following pages are an ODA document describing the records acquisition and data quality control process that ODA used in support of this EI.

Appendix C: Comparison Values Used to Evaluate Biological and Environmental Samples

Many State and Federal agencies develop comparison concentrations for chemicals in various media (urine, water, food, soil, etc.). The purpose of this Appendix is to explain how OHA selected and derived the comparison values (CVs) used in this report.

<u>Urine</u>

Urine is a unique medium for evaluating pesticide exposures because no clear associations have been drawn between specific urine concentrations and health outcomes in humans. OHA compared the urine results from this EI to those measured in the general population through the National Health and Nutrition Examination Survey (NHANES) and reported in the Fourth National Report on Human Exposure to Environmental Chemicals [20]. For 2,4-D, OHA compared the EI results to the NHANES 75th and 95th percentiles. OHA also compared the 2,4-D results to the biomonitoring equivalent (BE) for 2,4-D. A BE represents the estimated concentration of 2,4-D that would be present in the urine of a person who was chronically exposed to 2,4-D at a dose equal to EPA's reference dose (RfD) for 2,4-D. The BE for chronic exposures (lasting more than 7 years) to 2,4-D is 200 μg/L; for acute exposures (lasting one day), the BE is 400 μg/L for women of reproductive age and 1,000 μg/L for the rest of the population [23], [24]. There are no national reference values for atrazine in urine. Therefore, OHA searched peer-reviewed literature for smaller studies where the same atrazine metabolites were measured in human urine (see Table 12).

<u>Water and Soil</u>

OHA used ATSDR's hierarchy for choosing CVs for water and soil (Figure C1). If a hierarchy 1, 2 or 3 CV was not available, EHAP chose the lowest of EPA's Regional Screening Levels (RSL), U.S. Geological Survey's Health-based Screening Levels (HBSL), or EPA's Human Health Benchmark for Pesticides (HHBP). Tables C1 and C2 show the CVs used for water and soil respectively.

Figure C 1: ATSDR's hierarchy for selecting comparison values in water, soil, and air [6].

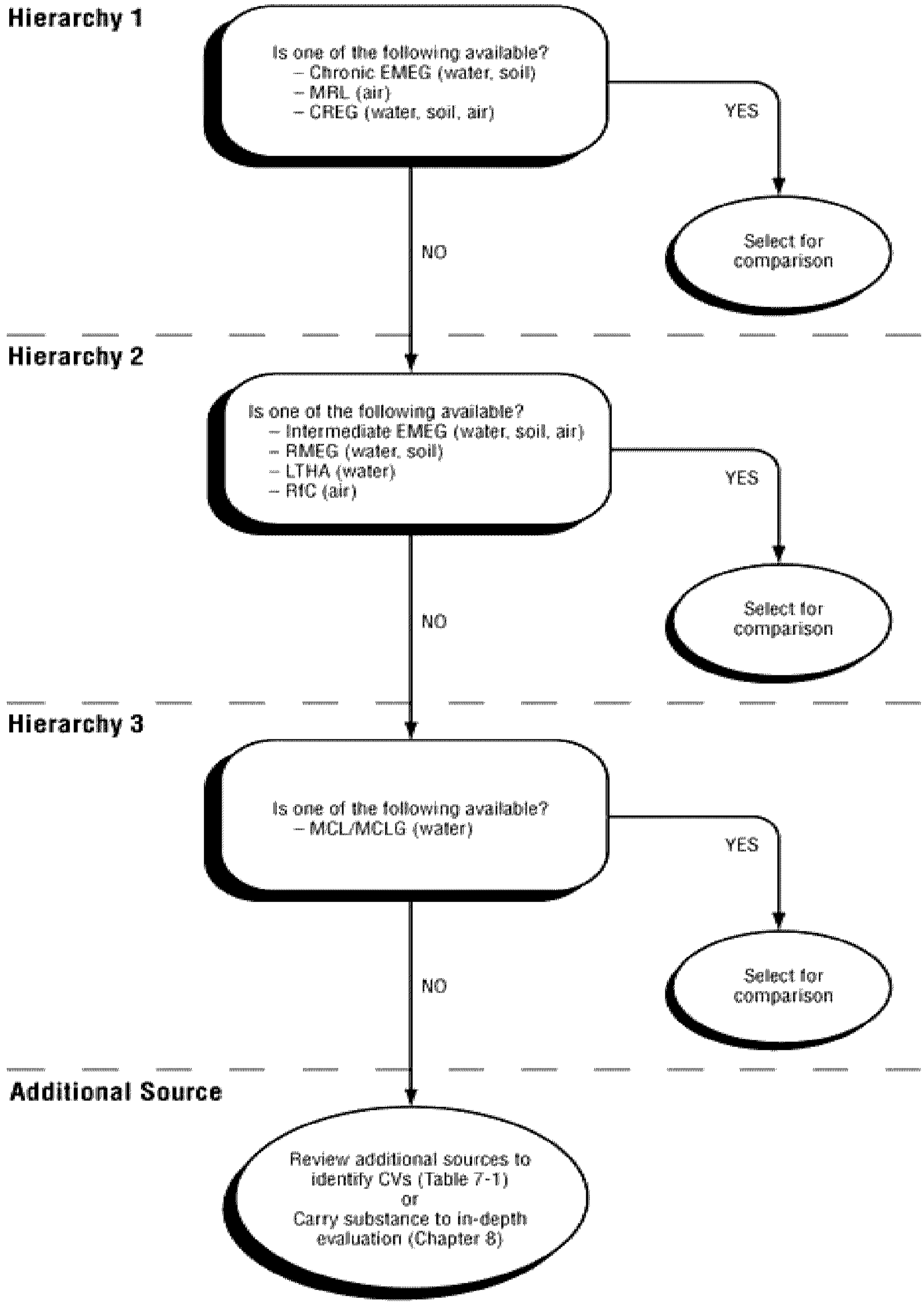


Table C 1: Analytes, detections, and comparison values for water samples.

Analyte	Detections (N = 37)**	Maximum Detected (ppm)	Comparison Value (ppm)	CV Source
2 (2,4,5-Trichlorophenoxy) propionic acid (2,4,5-TP/Silvex)	0	<0.00011	0.05	LTHA
2,4,5-Trichlorophenoxyacetic Acid 2,4,5 (2,4,5-T)	0	<0.00033	0.07	LTHA
2,4-Dichlorophenoxyacetic Acid (2,4-D)	0	<0.00011	0.1	RMEG
3,5-Dichlorobenzoic acid	0	<0.00033	NA	-
4-(2,4-dichlorophenoxy) butyric acid (2,4-DB)	0	<0.00066	0.08	RMEG
4-chloro-2-methylphenoxyacetic Acid (MCPA)	0	<0.022	0.005	RMEG
Acetamiprid	0	<0.0000041	0.5	HHBP
Acetochlor	0	<0.00001	0.2	RMEG
Acifluorfen	0	<0.00022	0.09	HBSL
Alachlor	0	<0.000031	0.1	RMEG
Aldrin	0	<0.000026	0.0000021	CREG
alpha-Chlordane (cis-Chlordane)	0	<0.000026	0.0001	CREG
alpha-Hexachlorocyclohexane (alpha-BHC)	0	<0.000026	0.000006	CREG
Ametryn	0	<0.0000041	0.06	LTHA
Aminocarb	0	<0.0000041	NA	-
Atrazine	0	<0.000051	0.03	Intermediate EMEG
Baygon	0	<0.0000041	0.003	LTHA
beta-Hexachlorocyclohexane (beta-BHC)	0	<0.000026	0.000019	CREG
Bifenthrin	0	<0.000082	0.091	HHBP
Bromacil	0	<0.000026	0.07	LTHA
Butachlor	0	<0.000026	NA	-
Butylate	0	<0.000026	0.4	LTHA
Carbaryl	0	<0.0000051	1	RMEG
Carbofuran	0	<0.0000041	0.05	RMEG
Chlorneb	0	<0.000026	0.09	HHBP
Chlorobenzilate	0	<0.000026	0.2	RMEG
Chlorothalonil	0	<0.000026	0.15	RMEG
Chlorpropham	0	<0.000026	2	RMEG
Cyanazine	0	<0.000026	0.001	LTHA
Cycloate	0	<0.000026	0.035	HHBP
Dacthal (DCPA - Dimethyl tetrachloroterephthalate)	0	<0.000026	0.07	LTHA
DCPA (Dimethyl tetrachloroterephthalate) acid metabolites	0	<0.00066	0.07	LTHA* (Parent: DCPA)
delta-Hexachlorocyclohexane (delta-BHC)	0	<0.000026	0.000006	CREG* (Parent: alpha-BHC)

Analyte	Detections (N = 37)**	Maximum Detected (ppm)	Comparison Value (ppm)	CV Source
Desethyl Atrazine	0	<0.0000041	0.03	Intermediate EMEG* (Parent: Atrazine)
Desisopropyl Atrazine	0	<0.0000041	0.03	Intermediate EMEG* (Parent: Atrazine)
Diazinon	0	<0.000026	0.007	Chronic EMEG
Dicamba	0	<0.00033	0.3	RMEG
Dichlorodiphenyldichloroethane (4,4'-DDD)	0	<0.000026	0.00015	CREG
Dichlorodiphenyldichloroethylene (4,4'-DDE)	0	<0.000026	0.0001	CREG
Dichlorodiphenyltrichloroethane (4,4'-DDT)	0	<0.000026	0.0001	CREG
Dichloroprop	0	<0.00033	0.3	HBSL
Dichlorvos	0	<0.000026	0.00012	CREG
Dieldrin	0	<0.000026	0.0000022	CREG
Dimethoate	0	<0.000026	0.002	RMEG
Dinoseb	0	<0.00033	0.007	LTHA
Diuron	0	<0.0000041	0.02	RMEG
Chlorpyrifos	0	<0.000026	0.01	Chronic EMEG
Endosulfan I	0	<0.000026	0.02	Chronic EMEG
Endosulfan II	0	<0.000026	0.02	Chronic EMEG* (Parent: Endosulfan I)
Endosulfan sulfate	0	<0.000026	0.02	Chronic EMEG* (Parent: Endosulfan I)
Endrin	0	<0.000026	0.003	Chronic EMEG
Endrin aldehyde	0	<0.000026	0.003	Chronic EMEG* (Parent: Endrin)
Ethoprophos	0	<0.000026	0.001	HBSL
Etridiazole (Terrazole)	0	<0.000026	0.112	HHBP
Fenamiphos	0	<0.000031	0.0007	LTHA
Fenarimol	0	<0.000026	0.042	HHBP
Fenvalerate/Esfenvalerate	0	<0.000512	0.25	RMEG
Fluometuron	0	<0.0000041	0.09	LTHA
Fluridone	1	0.000031	1.05	HHBP
gama-Hexachlorocyclohexane (Lindane)	0	<0.000026	0.0001	Intermediate EMEG
gamma-Chlordane (trans-Chlordane)	0	<0.000026	0.0001	CREG
Heptachlor	0	<0.000026	0.0000078	CREG
Heptachlor epoxide	0	<0.000026	0.0000038	CREG
Hexazinone	1	0.000183	0.4	HBSL
Imazapyr	0	<0.000041	17.5	HHBP
Imidacloprid	0	<0.00002	0.4	HHBP

Analyte	Detections (N = 37)**	Maximum Detected (ppm)	Comparison Value (ppm)	CV Source
Linuron (Lorox)	0	<0.0000041	0.005	HBSL
Malathion	0	<0.000026	0.2	Chronic EMEG
Methiocarb	0	<0.0000041	0.04	HBSL
Methomyl	0	<0.0000041	0.2	LTHA
Methoxychlor	0	<0.000026	0.04	LTHA
Methyl paraoxon	0	<0.000026	0.003	Chronic EMEG* (Parent: Methyl Parathion)
Methyl parathion (Parathion methyl)	0	<0.000026	0.003	Chronic EMEG
Azinphos-Methyl (Guthion)	0	<0.000041	0.03	Chronic EMEG
Methylchlorophenoxypropionic acid (MCPP)	0	<0.066	0.28	HHBP
Metolachlor	0	<0.000026	0.7	LTHA
Metribuzin	0	<0.000026	0.07	LTHA
Mevinphos	0	<0.000026	0.002	HHBP
Mexacarbate	0	<0.0000041	NA	-
Molinate	0	<0.000026	0.02	RMEG
N,N-Diethyl-3-methylbenzamide (DEET)	2	0.0000058	0.2	Minnesota Department of Health [21]
Napropamide	0	<0.000026	0.8	HBSL
Neburon	0	<0.0000051	NA	-
N-Octyl bicycloheptene dicarboximide (MGK 264)	0	<0.000051	0.427	HHBP
Norflurazon	0	<0.000026	0.01	HBSL
Oxamyl	0	<0.0000041	0.25	RMEG
Pebulate	0	<0.000026	0.05	HBSL
Penoxalin (Penoxsulam)	0	<0.000026	1.029	HHBP
Pentachlorophenol	0	<0.00011	0.000088	CREG
Permethrin	0	<0.000051	0.5	RMEG
Phosmet	0	<0.000026	0.004	HBSL
Picloram	0	<0.00066	0.5	MCL
Prometon	0	<0.0000041	0.15	RMEG
Prometryn	0	<0.0000041	0.04	RMEG
Pronamide	0	<0.000026	0.75	RMEG
Propachlor	0	<0.000026	0.13	RMEG
Propazine	0	<0.000026	0.01	LTHA
Propiconazole	0	<0.00002	0.07	HBSL
Pyraclostrobin	0	<0.0000041	0.24	HHBP
Pyriproxyfen	0	<0.000256	2.5	HHBP
S-ethyl dipropylcarbamothioate (EPTC)	0	<0.000026	0.25	RMEG
Siduron	0	<0.0000041	1	HBSL

Analyte	Detections (N = 37)**	Maximum Detected (ppm)	Comparison Value (ppm)	CV Source
Simazine	0	<0.000026	0.05	RMEG
Simetryn	0	<0.0000041	NA	-
Sulfometuron-Methyl	0	<0.0000041	1.9	HHBP
Tebuthiuron	0	<0.000026	0.5	LTHA
Terbacil	0	<0.000026	0.09	LTHA
Terbufos	0	<0.000041	0.0004	LTHA
Terbutryn	0	<0.0000041	0.01	RMEG
Terbutylazine	0	<0.0000041	0.002	HBSL
Tetrachlorvinphos (Stirophos)	0	<0.000026	0.3	HHBP
trans-Nonachlor	0	<0.000026	NA	-
Triadimefon	0	<0.000026	0.238	HHBP
Triclopyr	0	<0.00033	0.35	HHBP
Tricyclazole	0	<0.000026	NA	-
Trifluralin	0	<0.000026	0.0045	CREG
Vernolate	0	<0.000026	0.01	RMEG

N = Total number of samples; ppm = parts per million; CV = comparison value; < = Less than; NA = Not Available; - = Not Available; LTHA = Life-time Health Advisory; RMEG = Reference dose Media Evaluation Guide; HHBP = U.S. Environmental Protection Agency Human Health Benchmark for Pesticides [58]; HBSL = U.S. Geological Survey Health-Based Screening Level [59]; CREG = Cancer Risk Evaluation Guideline; EMEG = Environmental Media Evaluation Guide; MCL = Maximum Contaminant Level

* Comparison value for parent compound as surrogate for environmental degradates.
**37 samples include 36 drinking water samples and one surface water samples not used for drinking water.

Table C 2: Analytes, detections, and comparison values for soil samples.

Analyte	Detections (N = 29)	Maximum Detected (ppm)	Comparison Value (ppm)	CV Source
2,4-D	2	0.046	500	RMEG
Aminopyralid	0	<0.010	25,000	RMEG – provisional*
Atrazine	0	<0.010	150	Intermediate EMEG
Clopyralid	0	<0.010	25,000	RMEG – provisional*
Glyphosate	2	3.3	5,000	RMEG
Hexazinone	0	<0.010	2,000	RSL
Imazapyr	0	<0.010	125,000	RMEG – provisional*
Metsulfuron Methyl	0	<0.010	12,500	RMEG – provisional*
Picloram	0	<0.010	4,300	RSL
Sulfometuron Methyl	0	<0.010	13,750	RMEG – provisional*
Triclopyr	0	<0.010	2,500	RMEG – provisional*

N = Total number of samples; ppm = parts per million; CV = Comparison Value; < = less than; 2,4-D = 2,4-dichlorophenoxyacetic acid; RMEG = Reference dose Media Evaluation Guide; EMEG = Environmental Media Evaluation Guide; RSL = U.S. Environmental Protection Agency Regional Screening Level

*Provisional RMEG = Derived using the analyte's Reference Dose (RfD and the Agency for Toxic Substances and Disease Registry's drinking water RMEG equation for children. This was a fourth tier option because there were no other comparison values for these analytes.

Food

ATSDR does not have CVs for chemicals in food. Therefore, OHA used the hierarchy shown in Table C3 to select CVs for pesticides in food samples. Table C4 shows results for egg, milk and honey samples. Table C5 shows results for berry, leafy vegetable, and tomato samples.

Table C 3: Hierarchy used to select Comparison Values for food.

Hierarchy Level	Source of Comparison Value	Rationale
1	US EPA Pesticide Tolerance for foods [60]	Chemical and medium specific
2	Tolerance or equivalent from World Health Organization [61] or Health Canada [62] *	Chemical and medium specific
3	European Union Default Maximum Residue Limit [63] (0.01 ppm)	Not chemical or medium specific

US EPA = US Environmental Protection Agency; ppm = parts per million
*If both the World Health Organization and Health Canada had a tolerance for a particular food, chose the lower of the two tolerances.

Table C 4: Analytes, detections, and comparison values for egg, milk, and honey samples.

	Eggs				Milk				Honey			
Analyte	Detections (N = 4)	Max Detected (ppm)	CV (ppm)	Source	Detections (N = 2)	Max Detected (ppm)	CV (ppm)	Source	Detections (N = 2)	Max Detected (ppm)	CV (ppm)	Source
2,4-D	0	<0.01	0.01	WHO	0	<0.01	0.05	EPA	0	<0.01	0.01	EU
Aminopyralid	0	<0.01	0.01	WHO	0	<0.01	0.03	EPA	0	NR	0.01	EU
Atrazine	0	<0.01	0.04	HC	0	<0.01	0.02	EPA	0	<0.01	0.01	EU
Clopyralid	0	<0.01	0.1	EPA	0	<0.01	0.2	EPA	0	<0.01	0.01	EU
Glyphosate	0	<0.01	0.05	EPA	0	<0.01	0.05	WHO	0	<0.01	0.01	EU
Hexazinone	0	<0.01	0.01	EU	0	<0.01	11	EPA	0	<0.01	0.01	EU
Imazapyr	0	<0.01	0.05	HC	0	<0.01	0.01	EPA	0	<0.01	0.01	EU
Metsulfuron Methyl	0	<0.01	0.01	EU	0	<0.01	0.05	EPA	0	<0.01	0.01	EU
Picloram	0	<0.01	0.05	EPA	0	<0.01	0.25	EPA	0	<0.01	0.01	EU
Sulfometuron-Methyl	0	<0.01	0.01	EU	0	<0.01	0.01	EU	0	<0.01	0.01	EU
Triclopyr	0	<0.01	0.05	EPA	0	<0.01	0.01	EPA	0	<0.01	0.01	EU

N = Total number of samples; Max = maximum; ppm = parts per million; CV = Comparison Value; < = less than; 2,4-D = 2,4-dichlorophenoxyacetic acid; NR = No Result; EPA= US Environmental Protection Agency; HC = Health Canada; EU = European Union; WHO = World Health Organization

Table C 5: Analytes, detections, and comparison values for berry and vegetation samples.

	Berries				Vegetation (Leafy Greens/Tomatoes)			
Analyte	Detections (N = 4)	Max Detected (ppm)	CV (ppm)	Source	Detections (N = 14)	Max Detected (ppm)	CV (ppm)	Source
2,4-D	0	<0.01	0.2	EPA	0	<0.01	0.05	EPA
Aminopyralid	0	<0.01	0.01	EU	0	<0.01	0.01	EU
Atrazine	0	<0.01	0.01	EU	0	<0.01	0.25	EPA
Clopyralid	0	<0.01	0.5	EPA	0	<0.025	5	EPA
Glyphosate	0	<0.01	0.2	EPA	0	<0.04	0.1	EPA
Hexazinone	0	<0.01	0.6*	EPA	0	<0.01	0.01	EU
Imazapyr	0	<0.01	0.01	EU	0	<0.01	0.01	EU
Metsulfuron Methyl	0	<0.01	0.01	EU	0	<0.01	0.01	EU
Picloram	0	<0.01	0.01	EU	0	<0.05	0.01	EU
Sulfometuron-Methyl	0	<0.01	0.01	EU	0	<0.01	0.01	EU
Triclopyr	0	<0.01	0.01	EU	0	<0.01	0.01	EU

N = Total number of samples; Max = maximum; ppm = parts per million; CV = Comparison Value; < = less than; 2,4-D = 2,4-dichlorophenoxyacetic acid; EPA= US Environmental Protection Agency; HC = Health Canada; EU = European Union; WHO = World Health Organization

*For blueberries

Appendix D: Fall 2011 Survey Questions on Home/Work Pesticide Use

Hi ________

Thank you for participating in the Highway 36 pesticide Exposure Investigation. We have a few questions for you to answer, that will help us learn more about any potential exposure to pesticides or herbicides you may have had in the last several days. Please reply to this e-mail, with your responses to the questions below. Please call me at 971-XXX-XXXX if you have any questions. Thank you.

We were at your house on ____________________.

....

1. Approximately how much time per day did you spend outdoors around your home, in the week (7 days) before providing your urine sample? Is that typical for you?

2. Do you work at home?

3. Do you use any pesticides or herbicides on your land or in your garden?

4. Do you have a job where you handle or are around pesticides or herbicides?

    If Yes:

    What do you use?

    What application method(s) do you use?

    How much do you use on a weekly basis?

5. Did you use pesticides or herbicides in the week (7 days) before providing your urine sample?

    If Yes:

    When did you apply them?

    What did you use?

    Where did you apply it?

6. Do you know of any herbicide applications that occurred near your home (within a mile or so) in the week before you provided a urine sample?

    If Yes:

    Where did that application occur?

    When did that application occur?

    Do you know what method was used to apply them (backpack, aerial spray)?

Thank you for your time!

Appendix E: Chain of Custody for Community-Collected Urine Samples

Description of urine collection and shipment process

1. Community organizers assigned each participant a unique alphanumerical Personal Identification Number (PIN).
2. A medical doctor in Eugene, OR provided prescriptions for urine collection.
3. Participants had urine samples collected at a PeaceHealth laboratory facility per PeaceHealth's Urine Collection Process and protocols PHL.ALL.271.114, PHL.ALL.69.05, PHL.OR.394.57 and PHL.ALL.69.7
   a. Each participant had their identification verified using two sources of identification confirming their full name and birthdate.
   b. Participants verified their unique PIN.
   c. Each sample was labeled with the unique PIN and a unique PeaceHealth Laboratory accession number (PHLAN). No personally identifiable information (e.g., name, birthdate) were included on the sample label.
4. A PeaceHealth courier transported the urine samples from the collection site to the PeaceHealth Send Out Department. Each sample was accompanied by a packing slip that included the specimen label (with PIN and PHLAN) and a copy of the original prescription.
5. The PeaceHealth Send Out Department packed and shipped the samples via United Parcel Service or Federal Express to the lab at Emory University in Atlanta, GA.
6. Packaged samples were received by Central Shipping and Receiving (CS&R) at Emory University, and were delivered to the laboratory by an Emory University courier.

Laboratory Analysis

The urine samples were analyzed for 2,4-D and atrazine using CDC's laboratory methods for these chemicals [38], [39].

Reconstruction Process

In June 2012, after obtaining consent from 31 community urine collection participants, OHA began reconstructing and verifying the chain of custody from sample collection at PeaceHealth to delivery at Emory University. Forty-six of the 50 samples from consenting participants were collected at the PeaceHealth collection site in Eugene, OR. The other four samples were collected at a community hospital in Grants Pass, OR. These four samples were from two individuals who live outside the Exposure Investigation area and were excluded from further analyses in this PHA. A chain of custody was not established for those four samples.

To reconstruct and verify the chain of custody, OHA took the following steps:

1. Obtained and generated a list of PINs and PHLANs from:
   a. Copies of packing slips from packages received by the laboratory (provided by laboratory researcher on 6/12/2012);
   b. List of all consented participants with corresponding PINs and birthdates (provided by community organizers on 6/20/2012).
2. Sent PeaceHealth Client Services a list of PINs and corresponding PHLANs and birthdates

3. Obtained internal reports from PeaceHealth Client Services, Send Out Department, and Quality and Compliance to confirm the following for all 46 samples:
    a. Date and time the samples were picked up by the PeaceHealth Laboratory courier at the collection site;
    b. Date and time the samples were received at PeaceHealth's Send Out Department; and
    c. Date, time, ship-to address and method of shipment from PeaceHealth's Send Out Department to Emory University
4. Contacted Senior Operations Manager at the Rollins School of Public Health at Emory University, who confirmed the receipt of 26 samples by the CS&R at Emory University and the delivery of those 26 samples to laboratory.
5. Confirmed receipt of seven unanalyzed samples by CS&R at Emory University through the Federal Express tracking system.

Appendix F: Herbicides and Human Health

Herbicides are pesticides that are designed to be toxic to plants or specific types of plants. However, some herbicides have the potential to cause health problems in humans. In concentrated mixtures, herbicides can cause irritation to the skin and eyes if there is direct contact with these tissues. In general, the strongest scientific evidence on the health effects from herbicide exposures is from studies that examined relatively high levels of herbicide exposure. There is less certainty about the health effects of long-term exposure to lower doses, which characterizes the types of exposures the general public is most likely to experience. Some herbicides have been proven so harmful to human health that they have been banned. Others have been shown to be less toxic to humans.

Health Effects of 2,4-D and atrazine

Both 2,4-D and atrazine have the potential to harm human health. The types and severity of harm depend on the dose or how much of these pesticides get into the body. Pesticides are typically assessed for potential human health hazards based on laboratory studies in animals exposed to the pesticides via the diet and other routes of exposure. The lowest dose at which test animals show adverse effects is used as an endpoint for estimating potential risks to humans. Measurements of adverse effects are typically taken from studies of one-time or short-term exposures ("acute studies") and longer-term exposures ("chronic studies") to the pesticide.

2,4-D

In acute studies in rodents and rabbits, 2,4-D generally has demonstrated low acute toxicity via the oral, dermal, and inhalation routes of exposure. In people inadvertently exposed to 2,4-D in the short-term, the most common symptoms were dermal irritation and ocular problems. In chronic testing that serves as the basis for EPA's current human health risk assessment of 2,4-D, adverse effects observed in laboratory rats exposed to 2,4-D included gait abnormalities in a neurotoxicity study, skeletal abnormalities in pups in a developmental study, and decreased weight gain in a chronic toxicity study [64]. Some studies of pesticide exposures in humans ("epidemiology studies") have found links between 2,4-D and a specific type of blood cancer called non-Hodgkin's lymphoma, but other studies have not found evidence of this link. Because 2,4-D is often mixed with other herbicides, it is difficult for scientists to tell whether 2,4-D or other herbicides in the mix might be linked to cancer. Currently, scientists don't know whether 2,4-D can cause cancer in humans [64], [65]. EPA is currently updating its toxicology database and risk assessments for 2,4-D through an ongoing process referred to as registration review. As part of this process, EPA is reviewing studies specifically designed to address the potential for endocrine disrupting effects from 2,4-D.

The urinary half-life of 2,4-D is 18 hours in humans [36]. This is a relatively short half-life meaning that the human body rapidly eliminates 2,4-D.

Additional resources on the health effects of 2,4-D are available at the National Pesticide Information Center (NPIC): http://npic.orst.edu/factsheets/24Dgen.html

Atrazine

Adverse effects associated with laboratory animal testing with atrazine include delayed ossification of certain bones in fetuses, decreased weight gain in adults, disruption of hypothalamic function, and kidney lesions [31]. Based on epidemiologic evidence, EPA has concluded that atrazine is "not likely to be carcinogenic to humans." Atrazine is an endocrine disruptor meaning that it interferes with the body's hormone system. Atrazine seems to interfere with some of the hormones that control reproduction and development of the reproductive system. At higher doses, atrazine can cause liver, kidney, and heart damage in animals. It is possible that atrazine could cause these same effects in people, although no scientific studies have examined these outcomes in humans exposed to atrazine [31], [66]. EPA's registration review of atrazine is scheduled to commence during 2013. As with all chemical exposures the severity and risk of health effects depends on the dose a person actually gets.

The urinary half-life of atrazine is 24-28 hours in humans [37]. This is a relatively short half-life meaning that the human body rapidly eliminates atrazine. Atrazine is also rapidly metabolized into other compounds [31].

Additional resources about the health effects of atrazine can be found at the Agency for Toxic Substances and Disease registry. http://www.atsdr.cdc.gov/substances/toxsubstance.asp?toxid=59

Appendix G: ATSDR Glossary

The Agency for Toxic Substances and Disease Registry (ATSDR) is a federal public health agency with headquarters in Atlanta, Georgia, and 10 regional offices in the United States. ATSDR serves the public by using the best science available to take responsive public health actions and providing trusted health information to prevent harmful exposures and diseases related to toxic substances. ATSDR is not a regulatory agency, unlike the EPA, which is the federal agency that develops and enforces environmental laws to protect the environment and human health.

This glossary defines words used in this PHA when communicating with the public. It is not a complete dictionary of environmental health terms. If you have questions or comments, call CDC/ATSDR's toll-free telephone number, 1-800-CDC-INFO (1-800-232-4636).

Absorption:	How a chemical enters a person's blood after the chemical has been swallowed, has come into contact with the skin, or has been breathed in.
Acute Exposure:	Contact with a chemical that happens once or only for a limited period of time. ATSDR defines acute exposures as those that might last up to 14 days.
ATSDR:	The **A**gency for **T**oxic **S**ubstances and **D**isease **R**egistry. ATSDR is a federal health agency in Atlanta, Georgia that deals with hazardous substance and waste site issues. ATSDR gives people information about harmful chemicals in their environment and tells people how to protect themselves from coming into contact with chemicals.
Background Level:	An average or expected amount of a chemical in a specific environment or amounts of chemicals that occur naturally in a specific environment.
Cancer:	A group of diseases that occur when cells in the body become abnormal and grow, or multiply out of control.
Carcinogen:	Any substance shown to cause tumors or cancer in experimental studies.
Chronic Exposure:	A contact with a substance or chemical that happens over a long period of time. ATSDR considers exposures of more than one year to be *chronic*.
Completed Exposure Pathway:	See **Exposure Pathway**.
Comparison Value: (CVs)	Concentrations of substances in air, water, food, and soil that are unlikely, upon exposure, to cause adverse health effects. Comparison values are used by health assessors to select which substances and environmental media (air, water, food and soil) need additional evaluation while health concerns or effects are investigated.
Concern:	A belief or worry that chemicals in the environment might cause harm to people.

Concentration: How much or the amount of a substance present in a certain amount of soil, water, air, or food.

Contaminant: See **Environmental Contaminant**.

Dermal Contact: A chemical getting onto your skin. (See **Route of Exposure**).

Dose: The amount of a substance to which a person may be exposed, usually on a daily basis. Dose is often explained as "amount of substance(s) per body weight per day".

Environmental Contaminant: A substance (chemical) that gets into a system (person, animal, or the environment) in amounts higher than the **Background Level**, or what would be expected.

Environmental Media: Usually refers to the air, water, and soil in which chemicals of interest are found. Sometimes refers to the plants and animals that are eaten by humans. Environmental Media is the second part of an **Exposure Pathway**.

U.S. Environmental Protection Agency (EPA): The federal agency that develops and enforces environmental regulations to protect human health and the environment.

Exposure: Coming into contact with a chemical substance. (For the three ways people can come in contact with substances, see **Route of Exposure**.)

Exposure Pathway: A description of the way that a chemical moves from its source (where it began) to where and how people can come into contact with (or get exposed to) the chemical.

ATSDR defines an exposure pathway as having 5 parts:
1. Source of Contamination,
2. Environmental Media and Transport Mechanism,
3. Point of Exposure,
4. Route of Exposure, and
5. Population (Receptor).

When all 5 parts of an exposure pathway are present, it is called a **Completed Exposure Pathway**. When additional information is needed on one or more of the five parts, it is called a **Potential Exposure Pathway**. Each of these 5 terms is defined in this Glossary.

Frequency: How often a person is exposed to a chemical over time; for example, every day, once a week, or twice a month.

Ingestion:	Swallowing something, as in eating or drinking. It is a way a chemical can enter your body (See **Route of Exposure**).
Inhalation:	Breathing. It is a way a chemical can enter your body (See **Route of Exposure**).
kg	Kilogram or 1000 grams. Usually used here as part of the dose unit mg/kg/day meaning mg (contaminant)/kg (body weight)/day.
µg	Microgram or 1 millionth of 1 gram. Usually used here as part of the concentration of contaminants in water (µg/Liter).
mg	Milligram or 1 thousandth of 1 gram. Usually used here as in a concentration of contaminant in soil mg contaminant/kg soil or as in the dose unit mg/kg/day meaning mg (contaminant)/kg (body weight)/day.
MRL:	**M**inimal **R**isk **L**evel. An estimate of daily human exposure – by a specified route and length of time -- to a dose of chemical that is likely to be without a measurable risk of adverse, noncancerous effects. An MRL should not be used to predict adverse health effects.
PHA:	**P**ublic **H**ealth **A**ssessment. A report or document that looks at chemicals at a hazardous waste site and tells if people could be harmed from coming into contact with those chemicals. The PHA also tells if possible further public health actions are needed.
Point of Exposure:	The place where someone can come into contact with a contaminated environmental medium (air, water, food or soil). Some examples include the area of a playground that has contaminated dirt, a contaminated spring used for drinking water, or the backyard area where someone might breathe contaminated air.
Population:	A group of people living in a certain area or the number of people in a certain area.
Potential Exposure Pathway:	See **Exposure Pathway**.
Public Health Assessment(s):	See **PHA**.
Reference Dose (RfD):	An estimate, with safety factors (see **safety factor**) built in, of the daily, lifetime exposure of human populations to a possible hazard that is <u>not</u> likely to cause harm to the person.

Route of Exposure: The way a chemical can get into a person's body. There are three exposure routes:
– breathing (also called inhalation),
– eating or drinking (also called ingestion), and
– getting something on the skin (also called dermal contact).

Source (of Contamination): The place where a chemical comes from, such as a landfill, pond, creek, incinerator, tank, or drum. Contaminant source is the first part of an **Exposure Pathway**.

Special Populations: People who may be more sensitive to chemical exposures because of certain factors such as age, a disease they already have, occupation, sex, or certain behaviors (like cigarette smoking). Children, pregnant women, and older people are often considered special populations.

Toxic: Harmful. Any substance or chemical can be toxic at a certain dose (amount). The dose is what determines the potential harm of a chemical and whether it would cause someone to get sick.

Toxicology: The study of the harmful effects of chemicals on humans or animals.

Safety Factor Mathematical adjustments for reasons of safety when knowledge is incomplete. For example, factors used in the calculation of doses that are not harmful (adverse) to people. Safety factors are used to account for variations in people's sensitivity, for differences between animals and humans, and for differences between effect levels. Scientists use safety factors when they have some, but not all, the information from animal or human studies to decide whether an exposure will cause harm to people [also sometimes called an uncertainty factor].

Final

Public Health Assessment
Highway 36 Corridor Exposure Investigation

Prepared by the

Environmental Health Assessment Program
Oregon Health Authority; Public Health Division

Funded under a cooperative agreement with the
Agency for Toxic Substances and Disease Registry. (Grant no. 280603)

Foreword

The Oregon Health Authority (OHA), in cooperation with state and federal partners, prepared this Public Health Assessment (PHA). The Agency for Toxic Substances and Disease Registry (ATSDR) and its Oregon cooperative agreement partner, the Environmental Health Assessment Program (EHAP), conduct public health assessments to evaluate environmental data and community concerns. Contained within this PHA are the results of the Highway 36 Corridor Exposure Investigation (EI). The EI was conducted in response to resident's concerns about potential exposures from pesticide applications occurring on forestlands near their homes and schools.

At an April 2011 Board of Forestry meeting, several residents announced the results of a community-led, urine sampling effort. The results showed elevated levels of atrazine and 2,4-D in their urine. The Oregon Department of Forestry (ODF) notified the Pesticide Analytic and Response Center (PARC) of the results. As co-chair of PARC, OHA joined a multi-agency workgroup to develop the Highway 36 Corridor Exposure Investigation (EI) in order to determine if people are being exposed to pesticides in the Highway 36 corridor, and if so, the health implications of these exposures.

For the purposes of this document, the following definitions apply:

Public Health Assessment (PHA):
A PHA is an evaluation tool of choice when a site contains multiple contaminants and multiple, potential pathways of exposure. PHAs are conducted in an effort to determine whether a community is being exposed to environmental contaminants at levels that could harm human health. PHAs are not the same as medical exams, community health studies[1], or epidemiological studies[2]. A PHA is focused on a specific site or community~~,~~ and its findings are not intended to be generalizable to other sites or communities. **Sometimes critical data needed for a PHA are missing or not available. In such cases, ATSDR may conduct an Exposure Investigation (EI).**

Exposure Investigation (EI):
An EI is one approach used to better characterize past, current and possible future human exposures~~,~~ and to evaluate both existing and possible exposure-related health effects. An EI involves the collection and analysis of environmental data and, when appropriate, biologic data (such as urine or blood). The goal of an EI is to determine whether people have been, or are being, exposed to hazardous substances. An EI is one of several possible approaches to characterize past, current~~,~~ and possible future human exposures to environmental contaminants. An EI is not an epidemiological study or experiment. As such, some components of other types of studies, such as control groups, are not included in an EI.

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[1] A community health study (CHS) requires careful methods of measuring exposure and illness. Diseases can be caused by many different factors. It may be difficult to determine if a disease is caused by exposure to contaminants and not due to these other factors. A CHS presents many challenges~~,~~ and they are rarely conducted in small communities.

[2] Epidemiology (epi) is the study of the incidence, distribution and determinants of disease. Various methods can be used to carry out epi investigations, including descriptive studies used to study distribution and analytical studies to study determinants. The four most common types of epidemiological studies are 1) a cohort study, 2) a case-control study, 3) an occupational epi study, and 4) a cross-sectional study.

This PHA reports ~~out~~ on the results of the Highway 36 Corridor EI to date. It contains an analysis of information and data (qualitative, biologic and environmental) collected between April 2011 and September 2012. The EI findings are nested within the broader public health assessment process that ATSDR uses. Therefore, it is important to note that this PHA is the tool~~s~~ used to communicate the EI findings.

OHA serves as the lead agency for coordinating and implementing this investigation. Three other state agencies~~,~~ (which are members of PARC), and two federal agencies are involved in this effort. These agencies are:

- Oregon Department of Agriculture (ODA); Administrator of PARC
- Oregon Department of Forestry (ODF); PARC Member Agency
- Oregon Department of Environmental Quality (DEQ); PARC Member Agency
- Centers for Disease Control and Prevention (CDC)
  - Agency for Toxic Substances and Disease Registry (ATSDR) headquarters (Atlanta, GA) and Region 10 office (Seattle, WA)
  - National Center for Environmental Health (NCEH) laboratory (Atlanta, GA)
- U.S. Environmental Protection Agency (EPA)
  - EPA Region 10 (Seattle, WA)
  - EPA Office of Pesticides Programs (Washington, DC)
- PARC consultants from the Oregon Health and Science University (OHSU) and Oregon State University (OSU) also provide technical assistance and consultation for this investigation.

This group of agencies has provided input into the EI according to their areas of expertise and legal authority. For example, DEQ and EPA were responsible for collecting environmental data, and were key partners when writing pieces of the report related to the environmental samples. Each agency has reviewed the report and provided input, feedback and edits to the sections relevant to their agency. In addition, the group as a whole met several times to discuss issues as they arose and arrived at agreement on how to report ~~out on~~ the EI results. Funding and other staff resources used to conduct this EI was contributed by all state and federal agencies involved.

OHA Public Health Division (OHA/PHD) houses the Environmental Health Assessment Program (EHAP), which is the ATSDR-cooperative agreement program~~,~~ funded to carry out ATSDR's work in Oregon. EHAP staff are the primary authors of this report.

Purpose and Statement of Issues

This PHA reports on the available information and data collected to date for the Highway 36 Corridor EI. The Highway 36 Corridor is located in western Lane County, Oregon. The EI is a multi-agency response to several community members' requests to investigate possible exposures to pesticides and herbicides used in industrial forestland applications near their residences and schools. The purpose of the EI is to fill important data gaps by collecting and analyzing available information and environmental, biologic and qualitative data to answer the following questions:

1. Are residents in the Highway 36 Corridor being exposed to pesticides from local application practices?
2. If residents are being exposed:
    a. To what pesticides are they being exposed?
    b. To what levels are they being exposed?
    c. What are potential source(s) of the pesticides to which they are exposed?
    d. What are potential routes (pathways) of residents' exposures?
    e. What health risks are associated with these exposures?

As described in the "Background" and "Community Concerns" sections of this report, several Highway 36 Corridor residents are concerned about how these herbicide applications may be affecting their health. Therefore, this EI focuses on collecting and evaluating data on herbicides that are used in this area. Because "pesticide" is a more inclusive and commonly understood term, we use "pesticide" from this point forward to refer to herbicides, insecticides, fungicides, rodenticides and similar products regulated under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA).

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List of Abbreviations and Acronyms

2,4-D – 2,4-dichlorophenoxy acetic acid
ATSDR – Agency for Toxic Substances and Disease Registry
BE – Biomonitoring equivalent
CDC – Centers for Disease Control and Prevention
CS&R – Central Shipping and Receiving (at Emory University)
DACT – Diaminochlorotriazine, a metabolite of atrazine
DAAM – Di-dealkylated atrazine mercapturate, a metabolite of atrazine
DEA – Desethyl atrazine, a metabolite of atrazine
DEET -- N,N-diethyl-meta-toluamide is common ingredient in insect repellent
DEQ -- Department of Environmental Quality
EI – Exposure Investigation
EPA – U.S. Environmental Protection Agency
HOD – Health outcome data
g -- gram
L – liter
ODA – Oregon Department of Agriculture
ODF – Oregon Department of Forestry
OHA – Oregon Health Authority
OHSU – Oregon Health & Science University
OSU – Oregon State University
ng – nanogram
NCEH – National Center for Environmental Health
NHANES – National Health and Nutrition Examination Survey
µg – microgram
mg -- milligram
mL – milliliter
PARC – Pesticide Analytical Response Center
PHA – Public Health Assessment
PHLAN – PeaceHealth Laboratory Accession Number
ppb – parts per billion
ppm -- parts per million
PR – Pitchfork Rebellion
RfC – Reference Concentration
RfD – Reference Dose
SWG – Siuslaw Watershed Guardians

Summary

The Oregon Health Authority (OHA), in cooperation with state and federal partners, prepared this final report as part of an ongoing Exposure Investigation (EI) for the Highway 36 Corridor. OHA prepared this report under a cooperative agreement with the federal Agency for Toxic Substances and Disease Registry (ATSDR).

ATSDR's mission is to serve the public by using the best science, taking responsive public health actions and providing trusted health information to prevent harmful exposures and diseases related to toxic substances. OHA prepared this report in accordance with ATSDR's approved methods, policies and procedures existing at the date of publication.

Questions

The purpose of this EI is to answer the following questions:

1. Are residents in the Highway 36 Corridor being exposed to pesticides from local application practices?
2. If residents are being exposed:
    a. To what pesticides are they being exposed?
    b. To what levels are they being exposed?
    c. What are potential source(s) of the pesticides to which they are exposed?
    d. What are potential routes (pathways) of residents' exposures?
    e. What health risks are associated with these exposures?

As reported in this PHA, most of these questions have been answered to a limited degree.~~,~~ However, the investigation was not completed as planned, and~~although~~ uncertainties and data gaps remain. We recognize that the samples included in this report represent a snapshot in time and that air has not been adequately tested. In addition, most samples were collected during the time of year when pesticide use in the area was presumably at its lowest levels. The original plan was to conduct additional urine and environmental sampling immediately after pesticide applications occurred, in order to capture exposure conditions when pesticide levels in the environment (and presumably in people) would have been at their highest. The EI team was unable to do this additional sampling because of logistical challenges, which included changes to planned areas of application, the difficulty in collecting samples within 24-48 hours of an application and other issues. Because of the need for more data, and to overcome some of the logistical challenges, EPA is developing a passive air sampling method that will help answer questions about sources and routes of exposure (questions 2. c and d.). When the results of EPA's air monitoring become available, OHA will analyze, describe and report out on their public health significance.

Methods

OHA and its agency partners used qualitative and quantitative methods to carry out this EI. OHA analyzed information gathered from community meetings, interviews with residents, correspondences, and reviews of news stories and media coverage to describe the broad themes of community concerns.

OHA and its agency partners also collected samples of urine, drinking water, soil, and homegrown foods from residents in the area during August and September of 2011.

In July and August of 2011, OHA recruited participants at community meetings~~,~~ and through phone calls, direct mailings, flyers, a toll-free number~~,~~ and a listserv. To be eligible to participate, volunteers were required to:

- -live within 1.5 miles of a timber unit that had been harvested in 2010 or 2011,
- not be working as a pesticide applicator, and
- live within the defined exposure investigation area.

~~The h~~Homegrown foods, drinking water and soil samples were collected ~~tested~~ and analyzed for a list of pesticides that were ~~known to be~~being used in the area. All samples collected by OHA and partner agencies were intended as "baseline" samples, collected during the time of year when pesticide applications in the investigation area were presumably at their lowest levels.

Some members of the community living in this area conducted sampling of urine, surface water, and ambient air, independently of government agency oversight and at their own expense. The community-led urine sampling effort was carried out in the spring of 2011, and the water and air samples were collected at various times throughout 2011. Community-collected urine samples were sent to Dr. Dana Barr's laboratory at Emory University in Atlanta, GA, where they were analyzed for 2,4-D and atrazine. Community-collected air and water samples were analyzed by Anatek laboratory in Moscow, ID. Because these samples were collected by community residents and analyzed by non-governmental entities, OHA examined the quality control procedures of the sample collection and analysis and compared them with standards used by OHA and its agency partners, . The quality control procedures for the sample collection by the community and the analysis by the labs were determined to meet the standards used by OHA and its agency partners for inclusion in this report. Therefore, the conclusions and recommendations expressed here are based on data generated by both the EI team and the affected community members themselves.

Urine samples were analyzed for the presence of 2,4-dichlorophenoxy acetic acid (2,4-D)[3] and atrazine[4]. These are two pesticides used in forestry practices, for which there are laboratory methods developed to detect their presence in urine. Results of laboratory analyses for the urinary levels of 2,4-D were compared to data on 2,4-D levels found in the general US population, from the 2003-2004[5] National Health and Nutrition Examination Survey (NHANES). NHANES is a national survey designed to assess the health and nutritional status of the non-institutionalized US population. It is conducted by the federal Centers for Disease Control and Prevention (CDC).

No national comparison data are available for atrazine, because NHANES does not monitor for atrazine. The potential for health effects from the levels of 2,4-D detected in urine samples was determined by comparison against the acute and chronic biomonitoring equivalents (BE). The BE is the concentration of pesticide metabolites in urine that corresponds to the daily oral dose at which there is no known harm to health. No BE is available for atrazine.

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[3] For more information about 2,4-D see Appendix F of this document.
[4] For more information about atrazine, see Appendix F of this document.
[5] 2003-2004 are the most recent years of NHANES data that are publicly available

Water, soil and food samples were analyzed by the Oregon Department of Environmental Quality (DEQ) laboratory and the Oregon Department of Agriculture (ODA) laboratory. OHA compared measured concentrations of pesticides in water, soil, and homegrown foods against established health-based comparison values.

Results

Urine samples:
Urine samples collected by the community in the spring of 2011 were tested for 2,4-D and atrazine, the only two pesticides for which there are methods developed to test for in urine. The samples showed levels of 2,4-D that were statistically higher than the general U.S. population. In addition, all community-collected samples collected in the spring of 2011 contained detectible levels of atrazine metabolites.

As expected, ~~T~~the 66 urine samples collected by the investigation team in the fall of 2011 had levels of 2,4-D that were not statistically higher than levels found in the general U.S. population. None of the samples collected by the investigation team in the fall of 2011 contained detectable levels of atrazine metabolites. These results were expected because the samples were collected during baseline conditions, when 2,4-D and atrazine use in the area was at its lowest levels.

In all samples, levels of 2,4-D were below the biomonitoring equivalent (BE) for 2,4-D. A BE is the concentration of a chemical in urine (or other biological sample such as blood) that corresponds to the daily oral dose at which there is insignificant risk of harm to health. There are no national reference values for atrazine metabolites available for the general population, and there is not a BE established for atrazine. Therefore, it is not possible to compare the levels of atrazine metabolites found in the community-collected urine samples to levels that are expected to harm human health.

Drinking water samples:
Three of the 36 drinking water samples collected had detectable amounts of DEET, fluoridone, or hexazinone. DEET is a commonly applied product found in bug repellants. Fluoridone is an aquatic pesticide used to control weeds in ponds and hexazinone is a broad-spectrum pesticide used to control weeds.

Soil samples:
Three of the 29 soil samples collected had detectable amounts of 2,4-D and/or glyphosate (the active ingredient in the weed killer Roundup®). The concentrations of pesticides found in both soil and water samples were not at levels high enough to cause harm to human health, including for children and other population groups who may be especially sensitive to pesticide exposure.

Homegrown and wild grown food samples:
No pesticides were detected in any of the homegrown or wild grown food products sampled in the fall of 2011.

Air samples:

One out of 16 air samples collected by community members in May of 2012 contained a low but detectable amount of clopyralid. Clopyralid is a pesticide commonly used to control weeds and woody brush on forestlands and areas next to rights of way.

Community Concerns:
OHA has identified several causes of stress and conflict within the Highway 36 community. These include: concern and anxiety about health and safety; differing beliefs about pesticide use; the lack of adequate spray notifications; difficulty in obtaining records of pesticide applications; anger and distrust of government agencies; and what is viewed as the protection of large timber and chemical company interests above community rights. Some community members are confident that governmental requirements for pesticide labeling and use are protective of health. Others are skeptical and want the government to do more to protect their health. Some community members have requested an aerial spray buffer zone be established around homes and schools, while others are calling for a complete moratorium on all uses of pesticides. Community conflict, stemming from these divergent views, has escalated to a level where community cohesion has been negatively affected.

Conclusions

As a result of this EI, OHA reached *twenty-two* important conclusions addressing the questions that serve as the framework for this investigation about the presence, type and source of exposure to pesticides in the Highway 36 investigation area.

OHA reached *one* conclusion related to the question:
Are residents in the Highway 36 Corridor being exposed to pesticides from local application practices?

Conclusion 1: This investigation found evidence that residents of the investigation area were exposed to pesticides or herbicides in spring and fall 2011. However, it was not possible to confirm if these observed exposures occurred as a result of local application practices or were from other sources.
Basis for Decision: The urine sample analysis showed exposure to 2,4-D and atrazine. Environmental sampling in fall 2011 identified low levels of additional herbicides and DEET in soil and some water samples. Only one of the pesticides measured in fall 2011 environmental sampling (2,4-D) was the same as the pesticide measured in urine. Concentrations of 2,4-D measured in fall environmental samples were too low to explain concentrations measured in urine. In Spring 2011, there were no environmental samples that could be used to definitively link urine concentrations to specific pesticide applications.

OHA reached *four* conclusions related to the question:
To what pesticides are they being exposed?

Conclusion 2: Residents in the Highway 36 investigation area had urinary biomarkers for exposure to 2,4-D in spring and fall 2011, and atrazine in spring 2011. We were unable to determine if participants in the investigation had urinary biomarkers for exposure to pesticides other than 2,4-D and atrazine in spring or fall 2011.

Basis for Decision: OHA was unable to identify a laboratory that had the technical capability to test human urine samples for pesticides that are used in the area other than 2,4-D and atrazine.

Conclusion 3: Some Highway 36 investigation area residents may have been exposed to very low levels of DEET, fluoridone, or hexazinone in their drinking water.
Basis for Decision: DEQ detected very low concentrations of DEET, fluoridone, or hexazinone in three out of the 36 drinking water samples collected.

Conclusion 4: Some Highway 36 investigation area residents may have been exposed to very low levels 2,4-D or glyphosate in their soil.
Basis for Decision: ODA detected 2,4-D and/or glyphosate in three out of 29 soil samples collected.

Conclusion 5: Some Highway 36 investigation area residents may have been exposed to very low levels of clopyralid in the air.
Basis for Decision: One out of 16 air samples collected by community members in May of 2012 contained a low but detectable amount of clopyralid.

OHA reached *three* conclusions related to the question:
To what levels are they being exposed?

This investigation documented the presence of 2,4-D and atrazine in the urine of residents. There was a drop in those levels between the spring and fall 2011 for reasons that are currently unknown. There were no recorded applications of 2,4-D or atrazine in the months leading up to collection of these fall 2011 urine samples. However, 13 of the spring 2011 urine samples were also collected prior to any recorded 2,4-D or atrazine application and yet contained 2,4-D and atrazine metabolite concentrations significantly higher than the fall 2011 samples.

Conclusion 6: In the **spring of 2011**, Highway 36 investigation area residents had higher levels of 2,4-D exposure than the general U.S. population.
Basis for Decision: The concentrations of 2,4-D measured in the urine of participating Highway 36 investigation area residents in spring 2011 were statistically higher than those measured in the NHANES population. The NHANES population is representative of the general, non-institutionalized population of the United States.

Conclusion 7: In the **fall of 2011**, Highway 36 investigation area residents had urinary 2,4-D levels that were not statistically higher than the general U.S. population.
Basis for Decision: As expected, ~~T~~the concentrations of 2,4-D measured in the urine of participating Highway 36 investigation area residents in fall 2011, during the time of year when there were no reported 2,4-D or atrazine applications, were similar to those of the NHANES population. Measured concentrations were within the expected range as expressed by the NHANES 95th percentile. However, there was a slightly greater than expected number of participants whose urinary 2,4-D levels were in the upper quartile of the expected range. When compared to the NHANES 75th percentile the concentrations of 2,4-D in the urine of participating Highway 36 area residents were slightly higher with a difference that approached, but did not attain, statistical significance ($p=0.06$).

Conclusion 8: In the spring of 2011, urine samples from Highway 36 investigation area residents also had detectable levels of atrazine metabolites, but it is unknown how these levels compare to the general U.S. population.
Basis for Decision: The CDC did not test NHANES populations for the same metabolites of atrazine measured in participants of this EI. Without a reference population, it is not possible to determine how Highway 36 investigation area residents compare with other people with respect to urinary atrazine metabolite levels.

OHA reached *two* conclusions related to the question:
What are potential source(s) of the pesticides to which they are exposed?

Aerial and ground applications of 2,4-D, atrazine and other pesticides did occur in the investigation area in 2011. However, this investigation found that additional, unknown sources were a major contributor to the pesticides detected in participants' urinary 2,4-D and atrazine metabolite levels. In nine ~~cases~~participants, four documented aerial applications ~~probably~~ possibly contributed additional increases in urinary atrazine metabolites, but not 2,4-D.

Conclusion 9: There are additional sources of 2,4-D and atrazine in the investigation area that are not accounted for in the pesticide application records available to the investigation team.
Basis for Decision: For the spring 2011 samples, there was no statistical difference in 2,4-D and atrazine metabolite levels between the 13 urine samples collected before any known applications and the 26 urine samples collected after any known pesticide applications. As a group, the 39 spring 2011 urine samples had statistically higher 2,4-D and atrazine metabolite levels than the 64 fall 2011 urine samples, which were all collected three months after the last known forestry application of 2,4-D or atrazine. The spring 2011 samples, including the 13 pre-application samples, were also statistically significantly higher than the U.S. population as represented by NHANES.

Conclusion 10: Statistical associations suggest that four local aerial applications of atrazine and 2,4-D to forestland may have contributed to an increase in urinary atrazine metabolite levels in samples collected from nine ~~samples collected~~participants within 24 hours of those applications.
Basis for Decision: The EI team did not collect any environmental samples around the time of spring 2011 urine sampling. However, urine samples collected from nine ~~urine samples collected~~participants within 24-hours of four aerial applications of 2,4-D and atrazine to forestland had statistically higher levels of atrazine metabolites compared to the remaining 30 spring 2011 urine samples, but not 2,4-D. The four aerial applications took place within 2-4 miles of the residences of the nine EI participants with elevated atrazine metabolite levels. Because the investigation team did not have concurrent environmental samples detailing atrazine's persistence and distance traveled, we were unable to confirm that the known aerial applications were the source for the elevated atrazine metabolites that were detected in the nine residents' urine.

OHA reached *five* conclusions related to the question:
What are potential routes (pathways) of residents' exposures?

Low but detectable levels of DEET, fluoridone, or hexazinone were found in 8% of the drinking water samples. Glyphosate and/or 2,4-D were found in 10% of the soil samples. This suggests that in some cases incidental swallowing or absorption of pesticides from water or soil may be a path of exposure. No pesticides were found in the homegrown foods sampled, suggesting that this is an unlikely route of exposure.

> **Conclusion 11:** We were unable to determine whether air is a pathway of exposure to pesticides in the Highway 36 investigation area.
> *Basis for Decision:* Neither OHA nor the EI team members have had the funding or the staffing, logistical, technological or funding capacity to actively monitor air for the pesticides used in the area. Community-collected air samples were too few in number to provide the basis for eliminating or confirming air as a relevant exposure pathway.
>
> **Conclusion 12:** Drinking water was eliminated as an exposure pathway for 2,4-D and atrazine in the fall of 2011. *Basis of Decision:* As expected, ~~N~~no 2,4-D or atrazine -or their breakdown products - were detected in any of the water samples collected in the fall of 2011 at a time when there were no reported applications of these pesticides.
>
> **Conclusion ~~14~~13:** Soil sampled in the fall of 2011 was eliminated as an exposure pathway for the 2,4-D and atrazine detected in Highway 36 investigation area residents' urine.
> *Basis for Decision:* Concentrations of 2,4-D measured in two soil samples were far too low to explain the levels of 2,4-D found in Highway 36 investigation area residents' urine. In addition, most EI participants had detectable 2,4-D in their urine but no 2,4-D detectable in their soil.
>
> **Conclusion ~~15~~14:** Wild or homegrown food products sampled in the fall of 2011 were eliminated as an exposure pathway in the fall of 2011.
> *Basis of decision:*~~-~~ No pesticides were detected in any of the wild or homegrown food samples collected.
>
> **Conclusion 1~~3~~5:** Concentrations of pesticides in drinking water, soil and homegrown foods in the spring of 2011 and other seasons and years are unknown. *Basis of Decision:* Drinking water, soil and -homegrown food samples were only collected in the fall of 2011, at a time of year when there were no reported 2,4-D or atrazine applications.

OHA reached *five* conclusions related to the question:
What health risks are associated with these exposures?

This investigation documented the presence of 2,4-D and atrazine metabolites in the urine of residents. However, the levels of 2,4-D found in residents' urine are below the levels currently known to be harmful to health. OHA cannot determine whether measured atrazine metabolite levels pose a health risk to residents. The levels of the pesticides found in the water, soil and food samples were at levels below which we would expect to see harmful health effects.

Conclusion 16: The levels of 2,4-D measured in Highway 36 investigation area residents' urine in spring and fall 2011 were below levels expected to harm people's health.
Basis for Decision: The concentrations of 2,4-D measured were lower than the biomonitoring equivalent (BE) for 2,4-D. The BE is a calculated urine concentration that corresponds to an oral dose of 2,4-D associated with no harm to health.

Conclusion 17: We cannot determine whether the levels of atrazine metabolites measured in Highway 36 investigation area residents' urine in spring 2011 could harm people's health.
Basis for Decision: Unlike 2,4-D, there is no BE for atrazine metabolites. Without a BE against which to compare urinary atrazine metabolite levels, it is not possible to determine how measured urinary concentrations relate to doses that cause harm to health.

Conclusion 18: Drinking or contacting domestic water with the concentrations of pesticides detected in some Highway 36 investigation area properties in fall 2011 is not expected to harm people's health.
Basis for Decision: Three of 36 drinking water samples collected in fall 2011 within the Highway 36 investigation area had detected concentrations of pesticides. The concentrations measured at the time of sampling were thousands of times lower than health-based comparison values. The measured levels were too low to harm the health of people who drink the water, including sensitive populations such as children.

Conclusion 19: Contact with soil containing pesticides at the concentrations detected in the fall of 2011 in some Highway 36 investigation area soil is not expected to harm people's health.
Basis for Decision: Three of 29 Highway 36 investigation area soil samples had ~~any~~ measurable amounts of pesticides at the time of sampling. The concentrations measured at the time of sampling were thousands of times lower than health-based comparison values. Measured concentrations were too low to harm the health of people contacting the soil, including sensitive populations such as children.

Conclusion 20: Handling or consuming garden vegetables, berries, eggs, milk, or honey collected from the Highway 36 EI participants' homes in fall 2011 will not lead to harmful health effects related to pesticide exposure.
Basis for Decision: No pesticides were detected in any of the wild or homegrown food products sampled in the fall of 2011.

OHA reached *two* additional conclusions related to the impacts to the EI and to the health of community members from community conflict.

Conclusion 21: Divisions and hostility within the community~~,~~ related to ~~land use,~~ pesticide use, ~~and~~ property rights and land use~~,~~ are creating significant stressors on many individual community members and on the community as a whole.
Basis for Decision: OHA staff and other members of the EI team have observed, documented and responded to a high volume of complaints from a broad range of Highway 36 community members who express anger, frustration, mistrust, and fear. Community members express concerns about the intentions, motives and actions of others with opposing views on land use, pesticide use and property and human rights within and outside of their community.

Conclusion 22: Leadership activity within the community has been oriented toward debating issues of land use, pesticide use, and property rights. No formal or informal leader has yet emerged who has a mediating influence on these differences. Formal mediation services for the Highway 36 community may be necessary for both the successful completion of the EI and for the important progress needed to reduce community stress and improve community cohesion in the longer term.
Basis for Decision: Many community members have expressed frustration and concern about the degree and persistence of the conflict within their community and toward public agencies, timber industry practices and pesticide use. Regardless of the outcome of the EI, resolving these differences may be necessary to restore community cohesion.

Uncertainties and Limitations

As with any scientific investigation, there are uncertainties and limitations to our conclusions about exposure and health risks.

- **Fall 2011 environmental and urine samples were collected at a~~t~~ time when there were no reported 2,4-D or atrazine applications.** The EI team was not able to collect environmental or urine samples immediately after pesticide applications as planned due to unanticipated logistical challenges. Had samples been collected immediately after 2,4-D or atrazine applications, results might have better reflected conditions of high 2,4-D and atrazine use ~~conditions~~.
- **Household dust has not been evaluated as an exposure pathway.** Many pesticides are rapidly degraded in outdoor environments where they are exposed to sunlight, water and soil microbes. Indoor environments can shelter chemicals from these degrading forces, and pesticides may persist much longer indoors. Contaminants in soil tracked indoors on shoes can become part of household dust and persist much longer than would be predicted outdoors. This pathway has not been evaluated.
- **While community-collected urine and environmental samples are of sufficient quality to include in this PHA, these samples were not collected or analyzed with the same level of oversight as the fall 2011 samples collected by government agencies.** This difference in oversight resulted in some difficulties obtaining information about how and why participants were recruited, how and why sampling locations and times were selected, and what the creatinine levels in urine samples were. Creatinine is a natural component of urine that is used by doctors and scientists as a basic measure of kidney function. Creatinine levels fluctuate depending ~~up~~on how concentrated a person's ~~level of hydration~~urine is at the time of the sample. The samples OHA collected in the fall were adjusted for this difference, while the community-collected, spring samples were not.
- **Conclusions can only be drawn about the pesticides that were tested for in urine and environmental samples.** The urine samples collected in spring and fall 2011 were only tested for atrazine metabolites and 2,4-D. There were other pesticides used in the investigation area during the sampling times, but the only pesticides for which there are laboratory methods to test for in urine are 2,4-D and atrazine. The environmental samples collected in fall 2011 were tested for a wider range, but not an exhaustive panel, of pesticides. We cannot determine if, how and how much people were exposed to other pesticides at the time of sample collection. We also do not know what the health implications of any unknown pesticide exposures may be.

- **Conclusions about exposure and health risks only apply to the times and places where samples were collected by community members or the investigation team.** All urine and environmental samples represent a snapshot in time and space. Because 2,4-D and atrazine rapidly clear from the body, the levels of these chemicals in urine can only be used to assess recent (within 24-48 hours) exposures. The levels of pesticides detected in environmental samples only indicate the amounts present at the time of sampling, and do not indicate whether these levels have changed over time. We also cannot conclude if Highway 36 Corridor residents had past exposures to pesticides, if past or current exposures were from acute (short-term) or chronic (long-term) contact with pesticides, or if residents have had repeated exposures to pesticides over time.
- **It is not known if the EI resulted in changes to pesticide application practices in the investigation area, and therefore if exposure conditions have changed for Highway 36 Corridor residents.** It is unknown if pesticide applicators changed their pesticide application practices (i.e., application methods, locations, or types of pesticides used) after the EI was initiated. Any changes in local application practices will also change exposure conditions within the investigation area, and will make it difficult to fully answer the EI questions.
- **There is insufficient scientific evidence to determine the effect of exposure to multiple pesticides at low doses.** There is a limited but growing body of scientific evidence on the health effects from exposure to multiple pesticides; however, current methods do not allow for a determination of risk resulting from exposure to multiple chemicals.

Next Steps

Pertaining to the results of this EI, OHA recommends that:

1. US EPA work with the EI team on developing a sampling and analysis plan designed to evaluate exposures to pesticides in air and to address gaps in the data needed to answer EI questions. At the time of publication of this report, passive air monitoring over several application seasons appears to be the best option to collect community-wide air data.
2. ODA and ODF continue to provide pesticide application data as needed to interpret air sampling (or other) data collected as part of this investigation.
3. State and federal agencies involved in the ongoing EI develop an implementation plan that includes identification of necessary resources to carry out activities appropriate for each agency's role in this effort.

Pertaining to broader and/or longer-term issues identified by the EI, OHA recommends that:

1. -State agencies continue to collaborate on determining best practices that would protect human populations from pesticide exposures.
~~1.~~2. ODA and ODF work with pesticide applicators to develop consistent pesticide application record-keeping processes to ensure that application record data are accurately maintained and usable.
~~2.~~3. State agencies explore the feasibility of implementing a system that would allow people to be notified of imminent pesticide applications in such time and with such specificity that they could take action to avoid exposure to those applications. Such policies could include adoption of

systems developed by other jurisdictions~~,~~ or modification of existing regulatory systems designed to monitor pesticides applications.

3. ~~State agencies collaborate on determining best practices that would protect human populations from inadvertent pesticide exposures from aerial applications.~~
4. State and federal agencies involved in the ongoing EI develop an implementation plan to address these recommendations, including the identification of resources to carry out activities appropriate for each agency's role in serving the communities of Oregon. That plan should include a recommendation on how the agencies should coordinate, collaborate and share resources.
5. Community members, including local elected officials and other community leaders, consider seeking the assistance of a professional mediation group to address immediate and long-term conflict within the community and identify actions to move this conflict toward resolution.

OHA will:

- Work with state and federal partners, community members, and other stakeholders to implement the recommendations in this report.
- Provide updates through the Highway 36 web page and listserv about findings from:
    - The comparison of application records from 2011 to application records from 2009 and 2010 to determine if there were noticeable (substantial) changes in pesticide application practices after the EI was initiated in 2011.
    - Air sampling data once it is collected by the EPA.

Background

Investigation Area

The EI area includes the following Township-Ranges: 15S 06W, 15S 07W, 16S 06W, 16S 07W, 16S 08W, 17S 07W, 17S 08W, and 17S0 9W (Figure 1). The investigation area covers approximately 286 square miles (182,990 acres) in western Lane County and encompasses most of the communities along the Highway 36 Corridor.

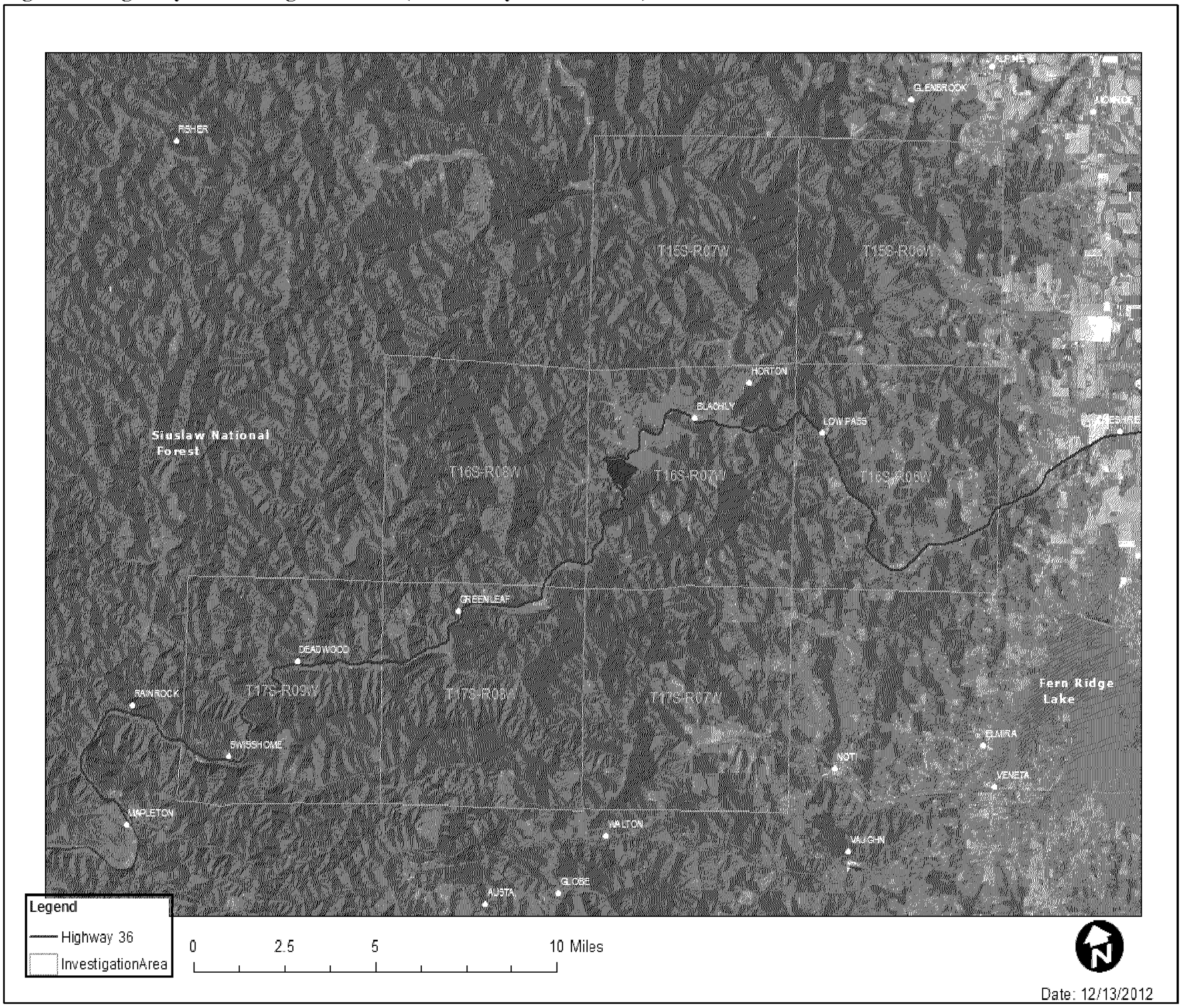
Recruitment Area

OHA established focused participant recruitment areas based on the proximity of residences to timber units that had been harvested in 2010 or 2011. All participants lived within the investigation area and within 1.5 miles of a 2010 or 2011 clear-cut.

Site Description

The investigation area is situated along a portion of Oregon state route 36 (Highway 36 in this report), which is a 52 – mile highway between the towns of Junction City and Mapleton in western Lane County. The Oregon Department of Transportation manages the highway and right of way. The investigation area includes the rural communities of Swisshome, Deadwood, Greenleaf, Triangle Lake, Blachly, Horton, and Low Pass. Approximately 2,161 people live in the investigation area. Approximately 1% (2,505 acres) of land in the investigation area is classified as rural residential. Approximately 5% (7,273 acres) is classified as agricultural land. According to the Oregon Department of Agriculture (ODA), agricultural production in the area includes pasture, hay, Christmas trees, small fruits, vegetables, and tree fruits. Forestry represents the majority of the land use in the investigation area and comprises approximately 95% (173,152 acres) of the classified use. Approximately half of the forestland in the investigation area is publicly owned, 25% is designated as privately owned industrial (ownerships greater than 5,000 acres) land, and the remaining 25% is designated as private non-industrial (ownerships less than 5,000 acres) [1]. Although forestry comprises 95% of the land use within the investigation area, land use percentages outside the investigation area vary dramatically, particularly to the east near Junction City, Eugene, and Harrisburg.

Figure 1. Highway 36 investigation area (shown in yellow outline).



Investigation History

Within the Highway 36 Corridor, there are residential properties located near forest, agricultural, or other residential lands where landowners may use pesticide products to control unwanted vegetation. Since 2005, some Highway 36-area residents have expressed concerns to Oregon state agencies about the human health and environmental effects from pesticide applications on nearby forest and agricultural lands. These residents have been advised by a consulting agronomist that the local geography and climate increase the likelihood of drift and re-volatilization of these pesticide applications to nearby residences and farms [2]. They have expressed a specific concern about aerial pesticide applications on harvested timberlands.

In 2005, a group calling itself the Pitchfork Rebellion (PR) began requesting that ODA address their concerns about alleged pesticide exposures from local application practices. In addition to being the

State's regulatory authority for pesticides, ODA administers the Pesticide Analytical Response Center (PARC). PARC is a multi-agency group with responsibilities to "centralize receiving of information relating to actual or alleged health and environmental incidents involving pesticides" and "mobilize expertise necessary for timely and accurate investigation of pesticide incidents and analyses of associated samples" [3].

In early 2010, PR petitioned the U.S. Environmental Protection Agency (EPA) to "conduct an unbiased study to determine what would be an appropriate aerial spray buffer zone for the specific conditions found along the Highway 36 Corridor in Lane County, Oregon" [4]. During a meeting with EPA Region 10 staff in April 2010, PR members reported instances of illnesses that they attributed to exposure to pesticides applied to forestlands near their homes [5]. In September 2010, EPA Region 10 requested the Agency for Toxic Substances and Disease Registry's (ATSDR) assistance in evaluating and addressing the health concerns raised by these residents and other organizations concerned about aerial pesticide applications on forestlands. In the winter of 2010, ATSDR Region 10 reviewed available information on illness reports and concerns from the area, conducted a site visit, and evaluated options to respond to local health concerns.

In spring 2011, 43 Highway 36 Corridor residents had their urine tested for pesticide metabolites by a researcher from Emory University (Atlanta, Georgia).[6] Based on the residents' assumption that aerial pesticide applications were the source of their health complaints, some community members collected urine samples both before and after aerial pesticide applications near their homes.

In April 2011, the researcher and a PR representative reported some of the community-collected urinalysis results at an Oregon Board of Forestry meeting. According to the presenters, the data indicated that:

- All of the submitted urine samples had detectable levels of 2,4-dichlorophenoxy acetic acid (2,4-D) and the atrazine metabolite diaminochlorotriazine (DACT).
- The researcher's presentation slides include a graph that compares purported "pre-spray" and "post-spray" 2,4-D and atrazine levels in participants' urine to the "U.S. population" which indicates higher levels in the local samples compared with the comparison.
- Some individual results showed that the 2,4-D and DACT levels in "post-spray" samples were higher than the levels found in "pre-spray" samples. The presenters ascribed the increase in concentrations to aerial applications on private forestlands. [7]

Shortly after these data were presented publicly, the Oregon Department of Forestry (ODF) notified PARC of information regarding actual or alleged health incidents involving pesticides in the Highway 36 Corridor. PARC agencies (OHA, the Department of Environmental Quality [DEQ], ODA, ODF, PARC consultants), ATSDR Region 10, and EPA Region 10 joined to form the Highway 36 Corridor EI team. The Governor's Office designated OHA as the lead state agency for the EI.

[6] See Appendix D for details on how spring 2011 urine samples were collected and tested. See the community-collected urine data section for OHA's interpretation of these data.
[7] The slides do not indicate the source of the "US comparison group", the total number of samples submitted, the numbers of "pre-spray" and "post-spray" samples, or the dates on which the samples were collected.

At the beginning of the investigation, the EI team did not have access to the biological sampling data presented at the April 2011 Board of Forestry meeting. Although some community members suspected aerial applications to forestlands, the investigation team broadened the investigation to evaluate local pesticide application practices and several potential exposure routes. This decision was supported by the presence of elevated 2,4-D and atrazine levels in all community-collected urine samples and not just those collected after a purported aerial pesticide application on forestland. The data presented in April 2011 suggested that residents could have chronic (or continuous) exposures to pesticides, possibly through contaminated drinking water or another source of exposure. The observed increase in 2,4-D and atrazine metabolites between first and second samples indicated there could also be acute (or short-term) exposures to pesticides after a nearby application. The investigation team chose a methodological approach to evaluate chronic and acute exposures from any local exposure source or pathway.

The EI team also began an extensive effort to open and maintain an active dialog with all of the residents in the investigation area. In keeping with ATSDR's approach to work with affected communities during an investigation, the EI team used a broad range of methods and venues to communicate with community residents, elected officials, industrial landowners, non-governmental organizations, trade organizations, technical experts, and other stakeholders. This communication effort was designed to provide community members with a variety of opportunities to receive information and share their thoughts and concerns about the investigation. It also provided the EI team important access to a broad range of community perspectives, as well as information on factors that could affect the design and implementation of investigation activities.

Discussion

Exposure Pathway Analysis

At the beginning of the EI, OHA conducted an exposure pathway analysis to identify the major pathways by which people could be exposed to pesticides in the Highway 36 Corridor. Exposure, which is defined as contact between a person and a chemical, can only occur if all of the following elements are present:

- a chemical source or released into the environment,
- a way or medium in which the chemicals move in the environment (e.g., water, soil, air, food),
- an exposure point or location where people come into contact with the chemicals,
- an exposure route by which people have physical contact with the chemicals (breathing it in, swallowing it, etc.), and
- an exposed population that comes into contact with the chemicals [6].

Scientists categorize exposure pathways as complete, potential, or eliminated based on their analysis of these five elements. In a complete exposure pathway, all five of these elements are present, indicating a strong likelihood that people could be exposed to a chemical. In a potential exposure pathway, one or more of the elements may be absent, but additional information is needed before eliminating or confirming the pathway. In an eliminated exposure pathway, exposure to a chemical is unlikely because at least one of these elements is absent. Scientists also attempt to determine if exposures occurred in the past, present, and/or future.

At the beginning of the EI, OHA identified five potential pathways by which Highway 36 Corridor residents could be exposed to pesticides in the environment (Table 1). OHA considered these "potential" pathways because at the outset of the investigation there were no environmental data to identify or rule out possible sources or pathways. OHA did not evaluate exposure to pesticide residues on food from retail grocery stores. While this is a valid and probable exposure pathway for many Highway 36 Corridor residents, it does not represent a unique local pathway that distinguishes this group from the general U.S. population. OHA also did not evaluate exposures to pesticides that occurred outside the investigation area. It is likely that many residents leave the study area periodically, which could cause them to be exposed to pesticides from uses other than those common to the investigation area.

Household dust is an additional potential exposure pathway that was not originally considered or evaluated in the EI. Many pesticides are rapidly degraded to less toxic byproducts in outdoor conditions where they are exposed to sunlight, water and soil microbes. In indoor environments, pesticides may be sheltered from these degrading forces and persist much longer [7], [8]. Studies have demonstrated that 2,4-D applied outdoors can be tracked indoors[9], [10]. The lack of indoor sampling standard methods and other logistical challenges makes it difficult to evaluate this pathway.

Table 1: Potential Exposure Pathways at the beginning of the Highway 36 Exposure Investigation.

Pathway	Source/Release*	Transport in environment (Media)	Point of Exposure	Route of Exposure	Exposed Population	Time
Air-borne particles	Aerial applications of pesticides and pressured ground sprays	Movement (drift) of chemicals off application sites (Air)	Outdoor air, indoor air	Breathing in chemicals in air	People who live or work near application areas	Past, present, future
Volatilized chemical vapors	Applications of pesticides	Volatilization of chemicals from soil to air (Air)	Outdoor air, indoor air	Breathing in chemicals in air	People who live or work near application areas	Past, present, future
Surface Soil	Applications of pesticides	Deposition of chemicals on surface soil (Soil)	Soil in gardens, yards	Swallowing, absorbing through skin	Gardeners, farmers, outdoor workers who have contact with surface soil	Past, present, future
Home-grown foods	Applications of pesticides	Deposition on, or uptake of, chemicals in garden vegetables, milk, eggs, etc. (Food)	Garden vegetable, milk, eggs, etc.	Eating	People who eat home-produced foods	Past, present, future
Drinking water	Applications of pesticides	Movement of chemicals through soil to groundwater or over land to surface water (Groundwater, surface water)	Tap	Drinking	Residents and other people who drink water from private ground/surface water sources	Past, present, future

*Aerial applications are primarily used on industrial forestlands in the Highway 36 Corridor. Ground applications include backpack spraying, "hack and squirt" applications, or roadside spraying by industrial or commercial landowners, government agencies, or private individuals.

Investigation Design

The EI team developed an investigation plan to evaluate the five potential exposure pathways and answer the EI questions. The EI team proposed to collect data during at least two sampling events: one in fall 2011 and one in spring 2012. The EI team implemented the fall 2011 sampling plan [11]~~[7]~~; this report discusses the corresponding methods and results. The EI team was unable to implement the spring 2012 sampling plan for reasons discussed in the "Spring 2012 Sampling" section below.

The EI team designed the fall 2011 sampling protocol to collect information about pesticide sources and exposure pathways, except air, under baseline or low pesticide use conditions. The spring 2012 sampling plan was intended to evaluate the air exposure pathway during spring aerial or ground spray pesticide applications. As part of the spring 2012 phase, the EI team planned to collect urine samples before and after a nearby aerial or ground spray pesticide application and collect air monitoring data during one or more pesticide applications.

> *A note about EIs:* EIs are not the same as epidemiological health studies and lack some key features commonly associated with epidemiological studies. For example, EIs are intentionally biased to seek out and test those individuals (or locations) expected to be most highly exposed (or contaminated). EIs are not randomized studies. EIs also do not identify or test control groups for comparison. This focuses all sampling resources on individuals at highest risk for exposure to and/or harm from environmental chemicals. EI results are not generalizable to populations outside of the ones tested in the investigation.

Fall 2011 Sampling

In August and September 2011, OHA, ATSDR, EPA and DEQ collected urine and environmental samples to evaluate if residents were being exposed to pesticides through drinking water, soil, and homegrown food. OHA recruited 66 participants from 38 households using the following methods [11]~~[7]~~:

- During a public meeting on July 14, 2011, OHA provided attendees with a flyer containing information on how to volunteer for the Fall 2011 sampling event. OHA sought assistance from local community members to circulate this flyer through several informal community networks and post it at prominent public locations throughout the community.
- OHA contacted people who signed in at the July meeting by phone and email. OHA also encouraged community members to give our contact information to other interested residents.
- OHA established a toll-free hotline dedicated to the recruitment of volunteers.
- OHA established a listserv to announce updates on the EI and to recruit more volunteers.

The criteria for participation in the EI were that volunteers lived inside the boundaries of the investigation area, lived within 1.5 miles of a timber unit that had been clear-cut in 2010 or 2011 and did not work as a pesticide applicator.[8]

ATSDR and OHA staff collected 66 urine samples from 38 households on August 30 and 31, 2011. The samples were immediately frozen on dry ice and then shipped overnight to the Centers for Disease Control and Prevention's (CDC's) National Center for Environmental Health (NCEH) laboratory in Atlanta, Georgia. Samples were tested for 2,4-D and atrazine[9] metabolites. These two pesticides were the focus of the EI's urine analysis for three reasons:

1) these pesticides were used in local agricultural and forestry applications;
2) the CDC has laboratory methods to test for these chemicals and national reference levels against which to compare the results for 2,4-D; and
3) these chemicals were tested in the spring 2011 community-collected urine samples.

EPA and DEQ staff collected drinking water, soil, and homegrown and wild food samples from the same 38 households on September 19 – 22, 2011. DEQ's laboratory in Hillsboro, Oregon analyzed the drinking water samples for a broad range of pesticides (see Appendix C for the complete list). All other environmental samples, including food and soil, were analyzed at the ODA laboratory in Portland, Oregon for pesticides used in both agricultural and forestry applications. DEQ and ODA laboratories used EPA-approved methodologies and quality assurance protocols [12]–[19]~~[8–15]~~.

Fall 2011 Urine and Environmental Sampling Results

Urine Results

The urine samples collected in fall 2011 were analyzed for 2,4-D and atrazine metabolites, and the results were compared to data from the CDC's *Fourth National Report on Human Exposure to Environmental Chemicals* [20]~~[16]~~. These national comparison data were collected as part of NHANES, a nationwide survey that includes monitoring for environmental chemicals in human blood and urine. NHANES is the best source of biomonitoring reference values for the general U.S. population because it is representative of the civilian, non-institutionalized U.S. population in terms of age, sex, and race/ethnicity. However, NHANES data may not reflect variations due to geographic location, season, or residence in urban versus rural areas [21]~~[17]~~.

These results were originally reported by ATSDR in the first formal report for the Exposure Investigation, *"Exposure Investigation: Biological Monitoring for Exposure to Herbicides, Highway 36 Corridor , Lane County, Oregon"*[21]~~[17]~~ released in March 2012. ATSDR's earlier report compared the EI urine results to NHANES values from 2001-2002; these were the most current NHANES data available at the time that report was released. In this current report, we compared the fall 2011 urine results against NHANES data collected in 2003-2004. Our use of 2003-2004 NHANES reference data explains the difference between this report's findings and the findings in the separate ATSDR report on

[8] According to ODF, these units were most likely to be treated with pesticides during the fall 2011 and spring 2012 spray seasons. In the original investigation plan, OHA planned to collect urine and environmental samples from the same participants and households in fall 2011 and spring 2012.
[9] See Appendix E for general information on 2,4-D and atrazine.

the fall 2011 urine samples. The 2003-2004 NHANES values used in this report are slightly higher than the 2001-2002 values.

None of the 66 EI participants had detectable concentrations of atrazine or its metabolites in their urine, indicating there were no recent exposures at the time of testing. Of the 64 EI participants over the age of six[10], 59 (92%) had detectable levels of 2,4-D in their urine. The 95th percentile of the EI participants was not statistically different than the 95th percentiles of the NHANES populations tested in 2003-2004 (Table 2). These were the expected results since samples were collected at a time when no known applications of 2,4-D or atrazine were occurring in the investigation area.

Table 2: Summary of urine results for 2,4-D from fall 2011 sampling.

Units	Mean	Median	Geometric mean	Range	95th percentile of EI (CI)	95th percentile of 2003-2004 NHANES (CI)
µg/L	1.14	0.33	0.37	<LOD -29.98	1.39 (0.98-29.98)	1.63 (1.31-2.37)
µg/g creatinine	1.15	0.37	0.4	<LOD -37.33	1.46 (0.92-37.33)	1.58 (1.24-2.34)
EI – Exposure Investigation; CI = 95% confidence interval; LOD = Limit of Detection (0.1 µg/L for EI); NHANES = National Health and Nutrition Examination Survey; µg/L = micrograms per liter; µg/g; micrograms per gram						

Three EI participants had creatinine-adjusted[11] urinary 2,4-D levels above the 2003-2004 NHANES 95th percentile (Table 3); this number was not statistically significant at the 95% confidence level and suggests that the range of 2,4-D levels is similar to the general population. Twenty-two EI (34.4%) participants had creatinine-adjusted urinary 2,4-D levels above the NHANES 75th percentile. The number of participants above the NHANES 75th percentile is not statistically significant at the 95% confidence level (alpha=0.05) but is significant at the less conservative 90% confidence level (alpha = 0.1). The marginally significant result when comparing to the NHANES 75th percentile indicates that there may be slightly more ~~individual~~participants than expected in the upper quartile of the expected range of creatinine-adjusted urinary 2,4-D.

[10] There are no NHANES values for comparison for children under six years old.
[11] Contaminant concentrations in urine are influenced by the hydration status and kidney function of the person who provided the sample. In many studies, these factors are controlled by relating contaminant levels to the amount of creatinine measured in urine. Creatinine is a urinary by-product of protein metabolism that is filtered by the kidney at a known and predictable rate. Urinary creatinine levels can vary greatly from person to person and depend on the individual's age, sex, body mass, and other factors [22]~~[18]~~.

Table 3: Fall 2011 creatinine-adjusted urine results for 2,4-D compared against NHANES 95th and 75th percentiles.

NHANES percentile level	EI urine results above NHANES percentile		One Sample binomial test	
	Number	Percent	95% Exact CI	Two-sided Exact p-value*
95th	3	4.7%	0 – 9	0.60
75th	22	34.4%	22.7 – 46.0	0.06

CI = 95% confidence interval; NHANES = National Health and Nutrition Examination Survey; EI = Exposure Investigation
*Typically, a p value equal to or less than 0.05 is considered statistically significant.

To evaluate the health significance of the urinary 2,4-D levels in EI participants, we compared the urine results to the biomonitoring equivalent (BE) for 2,4-D. A BE represents the estimated concentration of 2,4-D that would be present in the urine of a person who was chronically exposed to 2,4-D at a dose equal to EPA's reference dose (RfD) for 2,4-D. An RfD is an estimate of the daily oral exposure that people (including sensitive populations) could be exposed to over a lifetime without experiencing harmful health effects. The BE for chronic exposures (lasting more than 7 years) to 2,4-D is 200 µg/L; for acute exposures (lasting one day), the BE is 400 µg/L for women of reproductive age and 1,000 µg/L for the rest of the population [23], [24]~~[19-20]~~.

The maximum concentration of 2,4-D detected in an EI participant (30 µg/L) was about seven times lower than the chronic BE, and between 13 and 33 times lower than the acute BE for women of reproductive age and the general population respectively. The average 2,4-D concentration measured in EI participants' urine (1.14 µg/L) was 175 times lower than the chronic BE, and more than 350 times lower than the acute BEs. These data indicate that at the time of testing, EI participants were not exposed to 2,4-D at levels known to cause adverse health effects from acute or chronic exposures. The weight of available scientific evidence indicates that the 2,4-D levels measured in EI participants' urine do not pose public health risks.

Environmental Sampling Results

EPA, with assistance from DEQ, collected environmental samples, which included drinking water, soil, and community grown food samples from participating households. Thirty-six drinking water samples were collected from EI participants' homes. Nineteen of these samples were from domestic wells and 17 samples were from springs. A surface water sample was also collected from nearby Little Lake, which is not used as a drinking water source. EPA and DEQ collected 29 soil, 14 vegetation, four berry, four egg, two milk, and two honey samples from participating households. DEQ analyzed each water sample for over 100 chemicals (analytes), and ODA's lab analyzed all other samples for 11 analytes used in agricultural and forestland applications in the area. Appendix ~~B~~ C includes the list of analytes tested for in environmental samples.

Pesticides were detected in three (one analyte in each sample) of the 36 drinking water samples (Table 4). The three analytes detected were N,N-diethyl-meta-toluamide (DEET), hexazinone, and fluridone.

DEET was also detected in the sample collected from Little Lake. Each of these detections was below health-based screening values for these three chemicals. DEET is the active ingredient in many personal-use insect repellent products [25]~~[21]~~. Hexazinone is an herbicide used to control a broad spectrum of weeds including undesirable woody plants in alfalfa, rangeland and pasture, woodland, pineapples, sugarcane, and blueberries. It is also used on ornamental plants, forest trees, and other non-crop areas [26]~~[22]~~. Fluridone is an herbicide used to control aquatic weeds in ponds and lakes. Hexazinone is the only analyte detected that was listed in investigation area forest application notifications between 2009 and 2011.

The ODA lab detected at least one of the eleven pesticides in three of the 29 soil samples analyzed. Glyphosate and 2,4-D were both detected in one soil sample, and only 2,4-D or glyphosate was detected in the two other soil samples. The glyphosate and 2,4-D levels in these samples were below ATSDR's health-based screening values, which are 5,000 ppm for glyphosate and 500 ppm for 2,4-D (Table 4). None of the households with pesticides detected in their soil had any detectable pesticides in their drinking water. No pesticides were detected in any of the vegetation, berry, egg, milk, or honey samples collected in fall 2011.

Table 4: Fall 2011 environmental sampling results – detections in water and soil.

Location	Sample Type	Analytes Detected	Analyte Concentration (ppm)	Health-based Screening Value (ppm)	Source of screening value
Household 1	Domestic well water	DEET	0.0000047	0.2	Derived*
Household 2	Domestic spring water	Hexazinone	0.000183	0.2	HBSL
Household 3	Domestic well water	Fluridone	0.000031	0.4	HHBP
Little Lake	Surface water	DEET	0.0000058	1	Derived*
Household 4	Soil	Glyphosate	0.081	5,000	RMEG
	Soil	2,4-D	0.046	500	RMEG
Household 5	Soil	2,4-D	0.014	500	RMEG
Household 6	Soil	Glyphosate	3.3	5,000	RMEG

ppm = parts per million; DEET = *N,N*-Diethyl-3-methylbenzamide; HBSL = U.S. Geological Survey Health Based Screening Level; HHBP = U.S. Environmental Protection Agency Human Health Benchmark for Pesticides; RMEG = Reference dose Media Evaluation Guide; 2,4-D = 2,4-dichlorophenoxy acetic acid
* Derived using Agency for Toxic Substances and Disease Registry methodology and Reference Dose developed by Minnesota Department of Health (0.33 mg/kg-day) [27]~~[23]~~

Survey data

After urine samples were collected on August 30 and 31, 2011, OHA asked EI participants to complete a short survey on their pesticide use at home and place of work (see Appendix ~~C~~D for survey questions). Most EI participants were sent the survey via email and a few without internet access were contacted by phone. Forty-four (67%) of the 66 EI participants responded to the survey. Of the 44 respondents, 26 (59%) reported they did not use pesticides on their own land. Of the 18 who reported using pesticides on their land, a few respondents specified that they used Roundup® (active ingredient glyphosate), Weedmaster® (active ingredients 2,4-D and dicamba) or Crossbow® (active ingredients 2,4-D and triclopyr). Four (9%) survey respondents reported using pesticides at their place of work, and two of these four respondents had not used pesticides at work for the past several months. In the week prior to having their urine collected by ATSDR, none of the 44 survey respondents reported using pesticides at home or at work.

Comparison to Application Record data

OHA reviewed the available 2011 pesticide application data provided by ODF and ODA to determine if any commercial, public or private pesticide applications occurred during the fall 2011 urine or environmental sample collections.[12] The only reported commercial applications using 2,4-D or atrazine occurred in April, May, and early June, approximately three months prior to the urine testing (see Appendix B). Just prior to urine sample collection there were two aerial pesticide applications in the investigation area (August 28 and 29), however neither of these applications included 2,4-D or atrazine as active ingredients and would not have influenced urine sampling results. Two ground-based applications occurred during the urine sample collection (August 30th and 31st) and were as close as 0.3 miles to a participating household. The first application occurred on August 30 and used glyphosate, sulfometuron methyl, metsulfuron methyl, and imazapyr. The second application was a hack and squirt application on August 31 that used imazapyr. Neither of these applications used 2,4-D or atrazine (the chemicals that were tested in urine).

There were 13 reported pesticide applications on the days EPA and DEQ collected environmental samples (September 19-22). Eight applications occurred on September 20th, six of which were aerial applications on forestland. The eight applications on September 20th used the pesticides glyphosate, sulfometuron methyl, metsulfuron methyl, and imazapyr. One of these six aerial applications was as close as 1.1 miles from a participating household; the water, soil and vegetable samples collected from this household on September 22nd did not have pesticide detections. There were three applications of imazapyr on September 21st, one application of imazapyr on September 22nd, and one application of aminopyralid on September 22nd. The applications on September 21st and September 22nd were ground-based and located more than three miles from participating households.

Integration of Fall 2011 Data

Seven individual participants (in six households) who provided urine samples had pesticides detected in either their soil or drinking water (see Table 5). Two of these environmental samples had detections of 2,4-D, which was the only pesticide found in urine. The number of detections in environmental samples

[12] OHA obtained records of pesticide applications in the investigation area from 2009 – 2011, but only evaluated records from 2011 for this report. See Appendix A for additional information on 2011 application record data.

is too small to determine if there is a correlation between the 2,4-D levels measured in soil and the 2,4-D levels measured in urine.

The EI team cannot determine the sources of the pesticides detected in the fall 2011 drinking water or soil samples. In the survey administered by OHA shortly after the urine sample collection, all but one of the seven households with environmental sample detections reported using some kind of herbicide on their own property on a somewhat regular basis. Where specific products were named, Roundup® (active ingredient glyphosate) and Crossbow® (active ingredients 2,4-D and triclopyr) were the two most frequently used. However, none of the participants in these households reported using any pesticide products in the week prior to the urine sample collection. Further, application records indicate that none of the 13 known pesticide applications that occurred when EPA was collecting environmental samples~~,~~ contained the pesticides that were detected in drinking water (DEET, hexazinone, and fluridone). During the time the soil samples were collected, there were eight local pesticide applications that used glyphosate, which was detected in two households' soil samples. These applications were over three miles from these households, but some evidence suggests that under certain conditions some pesticides can travel long distances [28]–[35]~~[24], [25], [26], [27], [28], [29], [30], [31]~~.

Table 5: Combined Urine and Environmental Data from Fall 2011 sampling.

Household	Participant	Urine 2,4-D (µg/g-creatinine)	Drinking Water (ppm)	Soil (ppm)
Household 1	Participant A	0.29	DEET: 0.0000047	Non-Detect
Household 2	Participant B	0.61	Hexazinone: 0.000183	Non-Detect
Household 3	Participant C	0.24	Fluridone: 0.000031	Non-Detect
Household 4	Participant D	37.3	Non-Detect	Glyphosate: 0.081 2,4-D: 0.046
	Participant E	0.94		
Household 5	Participant F	0.38	Non-Detect	2,4-D: 0.014
Household 6	Participant G	1.12	Non-Detect	Glyphosate: 3.3

µg/g = micrograms per gram; ppm = parts per million; 2,4-D = 2,4-dichlorophenoxy acetic acid; DEET = *N,N*-Diethyl-3-methylbenzamide

Uncertainties/Limitations

All scientific processes involve some uncertainties. This section discusses some of the uncertainties and limitations related to the fall 2011 sampling and results.

- All samples collected in fall 2011 (urine, water, soil, and food) represent snapshots in time~~,~~ during a period when no known applications of 2,4-D or atrazi~~o~~ne had occurred in several months. This is especially true for urine results since 2,4-D and atrazine are cleared rapidly from the body [31], [36], [37]~~[32], [27], [33]~~. As such, any conclusions about exposure and health risks based on urine results only apply to the times these samples were collected.

- ~~Therefore, t~~The results of fall 2011 sampling do not tell us whether EI participants had past chronic, acute, or repeated acute exposures to 2,4-D or atrazine. Chemical exposures are typically more harmful the longer they last. An ongoing (chronic) exposure may be more concerning than a short-term (acute) exposure even if the short-term exposure is more intense (i.e., greater amount of a chemical enters the body).
- We do not know if participants' urine contained -other pesticides at the time of sample collection since we were only able to test for 2,4-D and atrazine metabolites in urine.
- Currently, there is little scientific information about the health implications of exposure to multiple chemicals at low doses.

Summary of Fall 2011 sampling

- At the end of August 2011, 59 (92%) of the 64 EI participants over six years of age had detectable levels of 2,4-D in urine.
- Statistical tests on urinary 2,4-D levels indicated that the range of levels was consistent with the general population at the time of sampling. Statistical comparisons at the 75th percentile were marginally significant (p-value=0.06); this indicates that there may be slightly more EI participants than expected in the upper quartile of the expected range.
- Three drinking water samples, one surface water sample, and three soil samples had detectable levels of pesticides (see Table 5).
- The levels of pesticides measured in urine, drinking water, surface water, and soil samples in fall 2011 are not expected to cause harmful health effects.
- There are insufficient data to determine if there is a statistically significant correlation between environmental sampling results and urine sampling results.
- All but one of the participants with pesticides detected in their environmental samples reported occasional or regular home use of herbicides, including those containing glyphosate and 2,4-D.
- None of the participants (including those with pesticides detected in their environmental samples) reported pesticide use in the week prior to urine sample collection.
- None of the known commercial pesticide applications that occurred during the fall 2011 urine sample collection used 2,4-D or atrazine.
- Eight of the 13 known commercial, public, or private pesticide applications that occurred during the fall 2011 environmental sample collection used glyphosate, which was detected in two households' soil samples. However, the applications occurred over three miles away from these households.
- Some evidence suggests that under certain circumstances, pesticides may travel long distances; therefore, it is unclear whether 2,4-D and glyphosate detections in participants' soil samples can be linked to known commercial, public, or private pesticide applications.

Spring 2012 Sampling/Investigation Suspension

In the original investigation plan, urine and air samples were to be collected in spring 2012 to evaluate the only medium (ambient air) not tested in fall 2011. The spring 2012 data would have been used to determine if aerial pesticide applications resulted in measureable levels of pesticides in air and in the urine of residents in the investigation area. OHA and ATSDR planned to collect urine from local residents prior to and immediately following aerial applications of 2,4-D and/or atrazine. EPA and DEQ planned to collect air samples during application events and test these samples for a wider range of pesticides.

The EI team suspended spring sampling on March 8, 2012 because the areas that were slated for spring applications of 2,4-D and/or atrazine were targeted in remote ~~locations which~~locations that have very few residents. In spite of significant effort, OHA was unable to recruit enough participants for pre/post-application urine sampling. Further, EPA and DEQ were not ready to conduct air monitoring at the time. After suspending the investigation, the EI team reassessed progress on answering the investigation questions, and considered options to fill the remaining data gaps. OHA decided not to pursue additional biosampling because of the technical and logistical challenges involved in a pre/post-application sampling design. These challenges include the limited number of pesticides able to be measured in urine; lack of appropriate comparison data for most pesticides in urine; the relatively short half-lives of 2,4-D and atrazine in urine; and difficulty in obtaining information about the exact timing of planned pesticide applications. EPA is developing a sampling method to passively monitor air for pesticides of interest. However, it is unlikely that air monitoring will occur until late 2014.

Community-Collected Data

ATSDR allows for the inclusion of community-collected data in EIs and provides guidelines for evaluating the quality of these data [6]. According to ATSDR guidelines, data should be weighted based on impartial data quality criteria and not on the credentials or background of the entity that provided or collected the data [6].

In early spring 2012, while OHA was trying to recruit participants for the pre- and post-spray urine sampling, some community members indicated their willingness to share the community-collected urine sample data collected in spring 2011. They also offered to share environmental data (water and air) they had collected at their own expense in the investigation area. The community members requested the EI team evaluate their data for inclusion in the EI. The EI team agreed to evaluate community-collected urine and environmental data for chain of custody, quality control, and their potential implications for exposure and human health.

Community members and the private consultants and laboratories they employed supplied OHA, DEQ, and EPA with all the documentation needed to evaluate the quality of the community-collected data. OHA, DEQ, and EPA reviewed this documentation and agree that the data are of sufficient quality to be analyzed and presented in this PHA (with the exceptions noted in the sections below). Details of our data quality evaluation process are presented in the sections below.

Community-Collected Urine Data

Community members in the Highway 36 Corridor collected urine samples in spring 2011 as part of their own assessment, independent of government agency oversight. Community organizers recruited 43 individuals to participate and organized the collection of 62 urine samples from these participants between February 8 and June 1, 2011. A research professor at Emory University in Atlanta, Georgia tested the urine samples received by her laboratory for evidence of recent pesticide exposures.

In May and June 2012, OHA obtained written informed consent from 29 participants who live in the investigation area to use their spring 2011 urine results for this PHA. OHA obtained these 29 participants' results directly from the Emory University researcher.

Residents' decision to collect samples

OHA contacted the 29 consenting individuals in the investigation area to learn more about the sequence of events that occurred around the time of the spring 2011 urine collection. We asked them to describe what prompted them to collect urine samples at various times between February and June 2011. About half the participants collected samples in February 2011 with the intention of having their urine tested before aerial pesticide applications began for the spring season. Participants used ODF's Notification of Operation system to determine when the spring application season would begin. As one participant stated, "We didn't just assume that there had been no spray. We had no notifications, and it was very much the end of the "no-spray" season. There is a good network of people out here with notifications; nothing had been scheduled for months." Other participants provided their first samples in March and April 2011.

Beginning April 9, 2011, community members started collecting second urine samples in order to capture what they believed were "post-spray" conditions. Over the course of the spring 2011 spray season, ten of the 29 consenting participants collected a second sample that was ultimately used in the EI (See next section for details). The ~~individuals'~~ participants' reasons for collecting a second sample vary, but several ~~people~~ participants reported collecting a second sample after:

- hearing, seeing, and/or filming an aerial spraying;
- receiving notification by email that a spray was occurring nearby; or
- feeling unwell or reportedly experiencing symptoms they attributed to nearby spraying.

One participant stated, "We were trying to figure out when to go for the 2nd test. But tracking sprays is impossible to do because there is too broad a scope of time between when you get notified and when they spray, so we just started getting sick one day at the same time, and went in to get tested after realizing we couldn't track it."

In May and June 2011, more ~~people~~ participants began providing initial urine samples because they either witnessed an aerial spray or experienced symptoms they attributed to nearby spraying.

Community urine sample collection, shipment, and laboratory analysis[13]

The 29 consenting participants within the investigation area provided 46 samples for the community urine collection. OHA verified that all 46 samples (100%) had a complete chain of custody from the time the residents had their urine collected at a PeaceHealth facility in Eugene, Oregon to the time PeaceHealth shipped the samples to Emory University (Table 6). OHA confirmed that Emory's Central Shipping and Receiving (CS&R) facility received 33 of the 46 samples (72%), and that the researcher's laboratory received 26 samples (57%). OHA was unable to verify a receipt date for 13 samples at either Emory CS&R or the lab. OHA also found that seven samples received by the lab were apparently not

[13] See Appendix D for detailed information on residents' sample collection, shipment, and laboratory analysis.

tested. In all, the researcher analyzed 39 of the 46 samples for 2,4-D and atrazine metabolites and provided these results to OHA. These 39 samples still represented all 29 individual participants, ten of whom provided samples at two different times. Urine samples were kept frozen throughout transport and in storage until the time of analysis. The researcher used CDC method 6107.01 [38]~~[34]~~ to analyze urine samples for atrazine metabolites and CDC method 6103.01 [39]~~[35]~~to test urine samples for 2,4-D. No field blanks were included with the community-collected samples.

Table 6: Chain of custody for 46 community-collected urine samples.

Number of Samples with Confirmed Collection Documentation at Peace Health	Number of Samples with Confirmed Transport Date by PeaceHealth Courier	Number of Samples with Confirmed Shipment Date from PeaceHealth to Emory	Number of Samples with Confirmed Receipt Date at Emory	Number of Samples with Confirmed Receipt Date at Lab	Number of Samples with 2,4-D/ Atrazine results from Lab
46	46	46	33	26	39
2,4-D = 2,4-dichlorophenoxy acetic acid					

OHA analysis of community-collected urine results

The researcher tested the 39 community-collected urine samples for 2,4-D and three metabolites of atrazine: diaminochlorotriazine (DACT), desethyl atrazine (DEA), and di-dealkylated atrazine mercapturate (DAAM). For ease of analysis and interpretation, we present atrazine results as atrazine equivalents. OHA was not able to adjust the urinary 2,4-D and atrazine results for creatinine because the 39 samples were not tested for creatinine. Results are presented as straight urine concentrations in micrograms per liter (µg/L). Table 7 shows basic descriptive statistics for the 39 community-collected samples.[14]

Table 7: Summary urine results (µg/L) from spring 2011 community-collected samples (N = 39).

Contaminant	Mean* (Range)	25th Percentile	50th Percentile	75th Percentile	95th Percentile
2,4-D	4.9 (0.7-31.7)	2.2	5.0	11.7	25.6
Atrazine equivalents†	5.0 (0.6-62.1)	2.4	4.8	11.4	29.8
*Mean is geometric mean; †Atrazine equivalents reflect the sum of measurements of the metabolites diaminochlorotriazine (DACT), desethyl atrazine (DEA), di-dealkylated-atrazine mercapturate (DAAM) 2,4-D = 2,4-dichlorophenoxy acetic acid					

All 39 samples had detectable levels of 2,4-D and atrazine metabolites. OHA compared the spring 2011 community-collected urine samples to the fall 2011 samples collected by ATSDR (Table 8) using a

[14]OHA used geometric means instead of arithmetic means in order to compare the EI data to NHANES data (which are reported as geometric means). Arithmetic means are calculated by adding up all the results and dividing the result by the number of results (n). Geometric mean is calculated by multiplying all the results and then taking nth root of the product.

statistical test called the Mann-Whitney U Test. For 2,4-D, the geometric mean in spring 2011 samples was significantly higher than the geometric mean in fall 2011 samples. Atrazine metabolites were found in all of the spring 2011 samples, while none were found in fall 2011 samples.

Table 8: Comparison of spring 2011 community-collected samples to fall 2011 ATSDR samples.

Contaminant	Spring 2011 Mean* (µg/L) (N=39)	Fall 2011 Mean* (µg/L) (N=64)	Mann-Whitney U Test (P Value)
2,4-D	4.9	0.37	<0.0001
Atrazine equivalents	5.0	None detected	-
*Geometric mean; µg/L = micrograms per liter; 2,4-D = 2,4-dichlorophenoxy acetic acid			

OHA determined that 20 of the 39 community-collected samples had the necessary documentation to establish a complete chain of custody from the time the samples were collected at PeaceHealth to the time they were delivered to Emory University. The missing documentation for the other 19 samples consisted of the slips confirming receipt at either Emory University's CS&R or the Emory laboratory. However, there was complete documentation confirming that the samples were shipped from PeaceHealth's shipping facility, and the Emory lab had results for these samples. This indicates that these 19 samples were actually delivered to the laboratory at Emory.

OHA conducted an additional statistical analysis to verify that these 19 samples were not statistically different from the rest of the samples. The average levels of 2,4-D and atrazine metabolites in the 19 samples without complete chain of custody were not statistically different from the average levels in the 20 samples with complete chain of custody (Table 9). Therefore, OHA accepted all 39 samples as valid test results, and all 39 were included in the analyses and conclusions presented.

Table 9: Comparison of urinary 2,4-D and atrazine levels by chain of custody, spring 2011.

Chemical	Incomplete custody sample mean* (N = 19)	Complete custody sample mean* (N = 20)	Wilcoxon two-sample P-value
2,4-D (µg/L)	6.2	3.9	0.1477
Atrazine Equivalents (µg/L)	6.6	3.8	0.1363
*Geometric mean; µg/L = micrograms per liter; N = number; 2,4-D = 2,4-dichlorophenoxy acetic acid			

Comparison to Application Record Data

After obtaining the community-collected urine data and the pesticide application records, OHA was able to identify the urine samples that were collected before and after known applications of 2,4-D and/or atrazine. Of the 39 community-collected samples, 13 were collected prior to any reported commercial applications of 2,4-D or atrazine. Of the remaining 26 samples, nine were collected within 24 hours of an application of 2,4-D or atrazine[15] and 17 were collected between 3 and 22 days after an application of 2,4-D or atrazine. The 24-hour time frame is significant because 2,4-D and atrazine are rapidly cleared from urine, so samples are most representative of exposures that occurred within the most recent 24-48 hours [31], [36], [37]. OHA reclassified the samples (independent from the classifications assigned by community members who provided the samples) as being either "pre-application" (N = 13) or "post-application" (N = 26). The subset of the post-application samples collected within 24 hours of a known application were classified as the "24-hour subset" (N = 9).

As previously mentioned, the 39 samples were provided by 29 participants; 10 participants provided two samples each. For each of these 10 participants, their first sample fell into the pre-application sample group, and their second sample fell into the post-application sample group. Therefore, no single participant had more than one sample in either the pre-application (N=13) or post-application (N = 26) sample groups.

For the ten participants with both pre- and post-application samples available, OHA was able to compare urinary 2,4-D and atrazine metabolite concentrations in pre- and post-application samples from the same participants (also known as a "matched pairs analysis"). This comparison was done using a statistical test called the Wilcoxon signed rank test. This test found no statistically significant difference between pre- and post-application urine samples for either 2,4-D ($p = 0.5$) or atrazine metabolites ($p = 0.11$). Out of the ten participants for whom OHA was able to compare pre- and post-application samples, seven collected their second sample within 24-hours of an application. Thus, these second samples were part of the 24-hour subset (N=9). The other three participants with available pre- and post-application samples collected their second samples 3-8 days after the most recent known pesticide application in the area. OHA did another matched pairs analysis of pre- and post-application samples including only those seven participants whose post-application sample was part of the 24-hour subset, using the same statistical test. This test also found no statistically significant difference between pre- and post-application urine samples for either 2,4-D ($p = 0.5$) or atrazine metabolites ($p = 0.3$).

OHA compared the average 2,4-D and atrazine metabolite concentrations of the 13 pre-application samples to the levels found in the 26 post-application samples (Table 10). There was no statistical difference between the two groups. This indicates a source of 2,4-D and atrazine exposure to participants that is not explained by any of the available application records.

[15] In 2011, there were 16 commercial pesticide applications that included the use of 2,4-D or atrazine. Thirteen of these applications occurred in April 2011 and three occurred in May 2011.

Table 10: Comparison of pre-application and post-application levels of 2,4-D and atrazine in urine, spring 2011.

Chemical	Pre-application sample mean* (N = 13)	Post application sample mean* (N = 26)	Exact Wilcoxon two-sample P-value
2,4-D (μg/L)	5.4	4.7	0.63
Atrazine Equivalent (μg/L)	5.3	4.8	0.72
*Geometric mean; μg/L = micrograms per liter; N = number; 2,4-D = 2,4-dichlorophenoxy acetic acid			

OHA also compared the average 2,4-D and atrazine metabolite concentrations of the nine 24-hour subset samples against those of the other 30 spring 2011 samples (Table 11). The levels of 2,4-D were statistically similar between the two groups. However, the levels of atrazine metabolites were significantly higher in the nine 24-hour subset samples.

Table 11. Comparison of urinary 2,4-D and atrazine metabolite levels between 24-hour subset and all other samples, in spring 2011.

Chemical	All samples not within 24 hours of application mean* (N = 30)	24-hour subset sample mean* (N = 9)	Exact Wilcoxon two-sample P-value
2,4-D (μg/L)	4.4	7.2	0.2312
Atrazine Equivalent (μg/L)	4.0	10.0	0.0450**
*Geometric mean; μg/L = micrograms per liter; N = number; 2,4-D = 2,4-dichlorophenoxy acetic acid ****Indicates a statistically significant finding (p < 0.05)**			

The higher levels of atrazine found in the 24-hour subset samples suggest that these samples were collected at a time when there were relatively higher levels of atrazine exposure among participating community members. Four known applications (three on one day and one on another) of atrazine were associated with the nine 24-hour subset samples. ~~In order to explain the higher levels in the 24-hour subset samples, OHA examined the application records for those times and locations. There were four known applications of atrazine that fit the relevant time period.~~ All four applications were aerial and co-applied with 2,4-D. These four applications were located between 2 and 3.8 miles from the homes of participants who ~~collected~~ provided these samples with the average distance being 2.65 miles.

~~While t~~There were no environmental monitoring data associated with these four applications, which ~~that~~ could have provided confirmatory site-specific information about the movement of atrazine from the application site to participants' homes. ~~,~~ T~~t~~here is evidence from other studies that suggest aerially applied pesticides in general [29], [30], [32]–[35]~~[25], [26], [28], [29], [30], [31]~~, and atrazine in particular [31]~~[27]~~, can travel long distances ~~move at least 2-4 miles away~~ from the application site.

Therefore, it is ~~probable~~ possible that local aerial atrazine applications contributed, alone or in part, to the relatively elevated levels of urinary atrazine metabolites detected in the nine 24-hour subset samples. However, it is also possible that the apparent increase reflects ~~the use of data unadjusted by creatinine (see *Uncertainties/Limitations* below). In addition, we do not know if there were~~ concurrent fluctuations in ~~the~~ unknown sources of atrazine exposure in the environment.

2,4-D

NHANES tracks 2,4-D nationwide but it does not track the atrazine metabolites measured in the community-collected urine samples. Therefore, we were only able to compare the spring 2011 urine results to NHANES data for 2,4-D results. All of the samples (N=39) had 2,4-D concentrations greater than the 2003-2004 NHANES 75th percentile (0.58 µg/L). Eighty-five percent (84.6%) of all spring 2011 samples (N = 39) had 2,4-D concentrations higher than the NHANES 95th percentile (1.63 µg/L). All of these differences were statistically significant (Table 12). This means that at the time the samples were collected, the 2,4-D levels in participants' urine were statistically higher than the levels found in the general U.S. population.

Table 12: Comparison of 2,4-D levels in community-collected urine samples (N = 39) to 2003-2004 NHANES* data.

	Values above NHANES 75th percentile (0.58 µg/L)		One Sample Binomial Test	Values above NHANES 95th percentile (1.63 µg/L)		One Sample Binomial Test
Samples	Number	Percent	Two-sided Exact p-value	Number	Percent	Two-sided Exact p-value
Total (N = 39)	39	100	<0.0001	33	84.6	0.025
µg/L = micrograms per liter; NHANES = National Health and Nutrition Examination Survey; N = number						

We also compared the community-collected spring 2011 urine results to published studies measuring urinary 2,4-D levels in pesticide applicators. The community-collected results were most similar to two studies of 2,4-D exposures among farm applicators [40], [41]~~[36], [37]~~ that found average pre-application 2,4-D levels of 7.8 and 3.8 µg/L, respectively.

To assess the potential health risks from the levels of exposure seen in community-collected urine samples, we compared the spring 2011 urine results to the biomonitoring equivalent (BE)[16] for 2,4-D. The BE was six times higher than the highest urinary 2,4-D concentration measured in spring 2011 samples (31.7 µg/L). OHA does not expect that the levels of 2,4-D exposures seen among participants in the spring 2011 urine assessment were high enough to pose risks to public health. Current scientific evidence indicates that none of the 2,4-D levels measured in Highway 36 Corridor residents in spring and fall 2011 indicate exposures that are expected to cause adverse health effects.

[16] See Fall 2011 Urine results for additional information on the 2,4-D biomonitoring equivalent.

Atrazine

In the case of atrazine, there are no national reference values against which to compare the spring 2011 urine results. Therefore, OHA searched peer-reviewed literature for smaller studies where the same atrazine metabolites were measured in human urine. Table 13 summarizes these studies. The levels of atrazine metabolites measured in spring 2011 urine samples were in the higher range of those found in pregnant women in France [42]~~[38]~~, lower than those found in turf applicators, and in the range of those measured in non-occupationally exposed individuals [43]~~[39]~~. In fall 2011, no atrazine or atrazine metabolites were detected in any of the participants, indicating that atrazine exposures were higher in spring than in fall.

Table 13: Atrazine metabolite equivalents measured in peer reviewed literature.

Study	Population	Median atrazine equivalents (µg/L)	Metabolites measured	Range (µg/L)
French women's study [42]~~[38]~~	Pregnant women in Brittany region of France (N = 579)	1.2[±]	DEA, DACT, DIA, atrazine mercapturate	ND – 17.1
Barr study [43]~~[39]~~	Individuals with occupational* exposures (N = 8)	Not reported	DEA, DIA, DACT, DAAM, ATZ, ATZ-OH, DEA-OH	100-510
	Individuals with non-occupational exposures (N = 5)	Not reported		10-235

µg/L = micrograms per liter, DEA = Desethyl atrazine, DIA = desisopropyl atrazine, DACT = Diaminochlorotriazine, DAAM = Didealkylated atrazine mercapturate, ATZ = atrazine, ATZ-OH = hydroxy atrazine, DEA-OH = hydroxy desethyl atrazine, N = number, ND = non-detect
± Median among detected values; *Commercial lawn care applicators

Unlike 2,4-D, there are no published BEs for atrazine metabolites, so it is not possible to compare these results against toxicity-based threshold values. Therefore, it is not possible at this time to determine if the levels of atrazine metabolites found in the spring 2011 urine samples could be associated with adverse health effects.

Uncertainties/Limitations

- The spring 2011 community urine samples were collected as part of an independent assessment. Aside from the application records provided by regulated pesticide applicators in the area, we do not have information on other potential sources of exposure that could explain the higher than expected levels of 2,4-D and atrazine metabolites found in these participants' urine samples.
- Contaminant levels in urine are influenced by the hydration status and kidney function of the person who provided the sample. In many studies, these factors are controlled by measuring the amount of creatinine (a urinary by-product of protein metabolism that is filtered by the kidney at a known and predictable rate) and relating contaminant levels to the amount of creatinine. Urinary creatinine levels can vary greatly from person to person, depending on the individual's age, sex, body mass, and other factors [22]~~[18]~~. Because the spring 2011 urine samples were not tested for creatinine, we were not able to control for the variables of hydration status or kidney function in our analyses.

Summary of community-collected urine data

- All 39 samples from 29 participants in the community urine collection had detectable levels of 2,4-D and atrazine metabolites.
- The levels of 2,4-D measured in the urine of 39 Highway 36 Corridor residents in spring 2011 were statistically higher than those found in the general U.S. population and statistically higher than the levels measured in Highway 36 Corridor residents in fall 2011. The levels of atrazine metabolites measured in spring 2011 were higher than the levels found in fall 2011.
- Higher than expected 2,4-D and atrazine metabolite levels in urine samples collected both before and after the start of known pesticide applications in the area indicate that there is an unknown source of these pesticides that is not accounted for in the application records available to OHA. It is possible that these results were influenced by environmental conditions, which fluctuate seasonally.
- The urinary levels of 2,4-D measured in spring 2011 were several times lower than the BE for 2,4-D (200 μg/L), and do not indicate a public health risk.
- We cannot determine if the levels of atrazine metabolites measured in spring 2011 pose health risks because there is no toxicity-based threshold for atrazine concentrations in urine.
- The levels of atrazine metabolites in community-collected urine samples were significantly higher in samples collected within a day of a known application of atrazine compared to samples that were not collected within a day of a known application. While the local applications of 2,4-D and atrazine ~~likely~~ may have contributed, in full or in part, to these increased concentrations, there is no concurrent environmental sampling data on atrazine's persistence or distance traveled from the application site to confirm that this is the case. There is conflicting evidence regarding whether the distance of two miles from the point of application to the participants' homes is sufficiently protective; in addition, we do not know if there were concurrent fluctuations in the unknown sources of atrazine exposure in the environment.

Community-Collected Environmental Data

Water (POCIS) Data

Some members of the community, called the Siuslaw Watershed Guardians (SWG), conducted surface water sampling within the investigation area, in the spring and summer months of 2011, independently and at their own expense. This section describes their work and results.

Methods

The SWG used Polar Organic Chemical Integrative Samplers (POCIS), which are designed to absorb organic chemicals that have dissolved in water. POCIS samplers are typically positioned in a stream and left for up to 28 days. Because of the long deployment time and continuous sampling, POCIS allows for measurement of very low concentrations of chemicals, in fact much lower than could be detected using traditional water sampling methods. However, results from POCIS samplers cannot be used to evaluate human exposure. This is because it is impossible to obtain the two pieces of information needed to calculate the concentration of a contaminant in water: the volume of water sampled by the POCIS (i.e. liters per day) and the associated uptake rate of the chemical (i.e., micrograms or milligrams of a contaminant). Therefore, POCIS results are mainly qualitative in nature and are reported as an amount of chemical per individual POCIS sampler (e.g., nanograms per POCIS or ng/POCIS) [44]~~[40]~~. In other words, we can describe the presence and amount of a chemical found in the POCIS sampler, but not the exact concentration in the water. POCIS data are often used to compare relative amounts of contaminants at one time or location with another time or similar location. For example, POCIS data can be used to compare contaminant levels in two tributaries or to monitor seasonal variations in contaminant levels in a particular stream.

The SWG deployed POCIS samplers at five locations shown in Table 14. Most samplers were deployed from April to May of 2011, but one was deployed from June to July of 2011. Duplicate samples were collected at two sample locations: Fish Creek (near the mouth) and Nelson Creek (downstream from Almaisie Creek). The SWG POCIS samplers were analyzed by Anatek labs in Moscow, Idaho for seven analytes: 2,4-D, atrazine, desethyl atrazine, desisopropyl atrazine, hexazinone, trichloropyridinol, and triclopyr. Desethyl atrazine and desisopropyl atrazine are breakdown products of atrazine.

With the permission of the community, Anatek Labs sent data and data quality assurance/control reports to DEQ for independent review. DEQ reviewed the raw lab data and Anatek' s quality assurance/control procedures. DEQ also compared the SWG sampling results to POCIS data collected by DEQ in other parts of the state. DEQ found that the SWG used valid sampling methods and that the analysis performed by Anatek Labs was appropriate and valid for the purposes of the study. DEQ provided OHA with a summary of their findings.

Results

The SWG POCIS samples contained atrazine, hexazinone, and desethyl atrazine (Table 14). Two of these contaminants, atrazine and hexazinone, are typically found by DEQ in waters throughout the state. However, streams where DEQ tends to find atrazine and hexazinone are larger than the ones tested by the SWG and tend to drain lands with more uses, including agriculture. The only documented pesticide applications upstream of the POCIS samplers were forestry related. Desethyl atrazine is not measured in DEQ's statewide Toxics Monitoring Program; therefore, we do not know if the presence of this chemical in SWG's samplers is unusual. DEQ frequently detects 2,4-D and triclopyr as part of its statewide POCIS monitoring, but neither of these chemicals were detected in the SWG samplers. Because these POCIS sampling results cannot be expressed as concentrations in water, OHA was not able to further evaluate these data by comparing them to health-based CVs for contaminants in water.

Uncertainties

There was no information about stream flow rate provided, and this creates some uncertainty in comparing results from one stream or location with another.

Table 14: Community POCIS data for surface water.

			Analytes (ng/POCIS)						
Sample Location	Deployment Dates	Lab Analysis Date	2,4-D	Atrazine	Desethyl Atrazine	Desisopropyl Atrazine	Hexazinone	Trichloropyridinol	Triclopyr
Fish Creek Near Mouth	4/17/2011-5/15/2011	9/8/2011	ND	52.3	15.9	ND	64	ND	ND
Fish Creek Near Mouth (Duplicate)	4/17/2011 - 5/15/2011	5/15/2012	NR	93	26.7	NR	81	NR	NR
Lake Creek Upstream of Fish Creek	4/17/2011 - 5/15/2011	9/8/2011	ND	15.8	0.9	ND	9.3	ND	ND
Congdon Creek a quarter mile from mouth	4/23/2011 - 5/21/2011	9/8/2011	ND	1.9	ND	ND	3.6	ND	ND
Unnamed drainage to Congdon Creek	4/23/2011-5/21/2011	9/8/2011	ND	ND	ND	ND	ND	ND	ND
Nelson Creek downstream of Almaisie Creek	6/3/2011 - 7/3/2011	9/8/2011	ND	ND	ND	ND	13.6	ND	ND
Nelson Creek downstream of Almaisie Creek (duplicate)	6/3/2011-7/3/2011	5/15/2012	NR	ND	ND	NR	16.8	NR	NR
ng = nanograms; POCIS = Polar Organic Chemical Integrative Samplers; ND = Not detected; NR= Not reported; 2,4-D = 2,4-dichlorophenoxy acetic acid									

Air Data

Highway 36 community members also conducted air sampling within the investigation area and submitted the results to OHA for review and inclusion in this PHA (Table 15).

Methods

Community members provided data on 16 air samples in the investigation area. Eleven samples were collected in October 2011, one sample was collected in March 2012, and four samples were collected in May 2012. Community members collected samples around Fish Creek, Triangle Lake, and private residences in the valleys below private timberlands. The 11 October samples and one March sample were intended as baseline data, meaning that no known pesticide applications were occurring when the samples were collected. The May 2012 samples were collected during and immediately following a pesticide application on nearby forestland.

Samples were collected using Tisch Environmental, Inc. Te-PUF Polyurethane foam high volume active air samplers according to the manufacturer's instructions.[17] Field blanks accompanied and were analyzed along with each of the samples. Each sample was collected over approximately 12 hours resulting in total collected air volumes ranging from 77 – 147 m^3. The samples were sent directly to Anatek Labs in Moscow, Idaho for analysis. Anatek labs analyzed each sample for 27 chemicals: clopyralid; 2,4,5-trichlorophenoxyacetic acid (2,4,5-T); 2-(2,4,5-Trichlorophenoxy)propionic acid (2,4,5-TP or Silvex); 2,4-dichlorophenoxy acetic acid (2,4-D); 4-(2,4-dichlorophenoxy)butyric acid (2,4-DB); dacthal; dalapon; dicamba; dichloroprop; dinoseb; 2-methyl-4-chlorophenoxyacetic acid (MCPA); picloram; atrazine; chlorsulfuron; desethyl atrazine; halosulfuron; hexazinone; imazapyr; imazosulfuron; iodosulfuron; metsulfuron methyl; nicosulfuron; prosulfuron; rimsulfuron; sulfometuron methyl; triasulfuron; and tiflusulfuron methyl.

Results

Most of the air samples were non-detect for all 27 chemicals tested. Six of the 11 samples collected in October tested positive for 2,4-D. The field blanks associated with four of these six samples also tested positive and contained similar amounts of 2,4-D. This indicates that these four samples were likely contaminated and ~~cannot be used as valid results~~must be classified as non-detects. One of these field blanks also tested positive for picloram, but picloram was not detected in the main sample. Because of these contamination issues, OHA and DEQ do not consider the October air sample results to be valid.

One of the four samples collected in May, which was collected during an observed pesticide application to nearby forestland, had a positive detection of clopyralid at 0.37 ng/m^3. This appears to be a valid result, as the field blank was clean. OHA does not currently have access to the pesticide application records that correlate to the observed application. However, clopyralid was one of the pesticides listed on the notification record associated with that harvest unit.

[17] This type of active sampling is different from the passive air sampling methods that EPA is working to develop. Active sampling requires a power source and tight coordination with pesticide applicators to know exactly when to start the 12-hour sample collection window. Passive sampling would not require a power source or this type of coordination.

There is no established health-based screening level for clopyralid in air. However, there is a standard method for converting an oral reference dose (RfD) into a reference concentration (RfC) [45]~~[41]~~. An RfC is an estimate of a continuous inhalation exposure concentration that is likely to be without risk of harmful effects during a lifetime of exposure. An RfC builds in safety margins that are intended to be protective of the most sensitive populations.

Appling this method to clopyralid's RfD (150 µg/kg-day) [46]~~[42]~~ yields an RfC of 525,000 ng/m^3. The level of clopyralid measured in the community-collected air sample (0.37 ng/m^3) is over a million times lower than the calculated RfC. This indicates that the level of clopyralid measured at this time and location is unlikely to pose a public health risk.

Table 15: Community-collected air data – valid detections.

Collection Date	Detections /Valid Samples	Analytes Detected	Maximum Analyte Concentration Detected (ng/m^3)	Health-based Screening Value (ng/m^3)	Source of screening value
May 2012	1/4	Clopyralid	0.37	525,000	Derived RfC*

ng/m^3 = nanograms per cubic meter; 2,4-D = 2,4-dichlorophenoxy acetic acid; RfC = Reference Concentration
*Derived from the U.S. Environmental Protection Agency's oral reference dose for clopyralid [46]~~[42]~~

Uncertainties

- Each of these samples was collected over an approximate 12-hour time period, and the results represent a snapshot in time. Therefore, it is unknown whether the results are typical for the locations or times sampled.
- The derived RfC for clopyralid is based on chronic or long-term exposure. It is not ideal to compare a 12-hour sample to a chronic RfC. However, no short-term or acute inhalation toxicity values for clopyralid are currently available. In general, short-term and acute toxicity values are higher than chronic toxicity values. Therefore, comparing a short-term sampling result to a chronic RfC is a conservative approach that is protective of health.
- The method for extrapolating an RfC from an oral RfD is not as precise or as valid as an RfC derived from actual inhalation toxicology studies. Some chemicals have different toxicities and endpoints depending on the route of exposure (i.e., inhalation vs. ingestion). The calculated RfC does not account for inhalation-specific toxic effects. Chemicals may come into contact with different organs when inhaled as opposed to ingested. This can lead to differential toxicity based on the sensitivity of the organ that comes into contact with the chemical. Therefore, this calculated RfC might be more or less protective than a traditionally derived RfC. However, clopyralid would have to be over a million times more toxic via the inhalation route than the ingestion route for the measured concentration to pose a public health risk. While many chemicals are more toxic via the inhalation pathway than the ingestion pathway, it is unusual for the difference in toxicity to be as great as a million fold.

Evaluation of Health Outcome Data

~~The Superfund law requires~~ ATSDR requires ~~and~~ its cooperative agreement partners to consider if health outcome (i.e., mortality and morbidity) data (HOD) should be evaluated in a PHA [6]. The main requirements for evaluating HOD are: the presence of a completed human exposure pathway; a known time period of exposure; a quantified population that was (or is being) exposed; sufficient contaminant levels and time to result in health effects; and the availability of systematically collected HOD for the health outcomes associated with chemicals in the pathway [6].

The Highway 36 Corridor investigation does not meet the requirements for including an evaluation of HOD as part of this assessment.. There are two main reasons we did not evaluate HOD. First, we do not know how many people have been (or are being) exposed to pesticides in the Highway 36 investigation area. Second, there has been no systematic measurement HODs related to pesticide exposure. Further:

- The environmental data collected in fall 2011 indicate that people were not being exposed to pesticides in drinking water, soil, or homegrown foods at levels that could harm human health.
- The levels of 2,4-D measured in community members' urine in spring and fall 2011 were below levels of health concern.
- For community residents who had atrazine detected in their urine in spring 2011, we do not know if they were exposed at levels that could result in health effects and if enough time has passed for these health effects to develop. We also do not know which effects to look for because there is limited scientific evidence on the health effects associated with atrazine exposure. Atrazine is a known endocrine disrupter that has been associated with hormonal and reproductive effects in animals and humans. However, there is currently not enough evidence to identify the specific effects associated with low-level exposures to atrazine in humans (See Appendix F).

Children's Health Considerations

OHA and ATSDR recognize that infants and children may be more vulnerable to exposures than adults in communities faced with contamination of their air, water, soil, or food. This vulnerability is a result of the following factors:

- Children are more likely to play outdoors and bring food into contaminated areas.
- Children are shorter, resulting in a greater likelihood to breathe dust, soil, and heavy vapors close to the ground.
- Children are smaller, resulting in higher doses of chemical exposure per body weight.
- The developing body systems of children can sustain permanent damage if toxic exposures occur during critical growth stages.
- Children are more likely to swallow or drink water during bathing or when playing in and around water.
- Children are more prone to mouthing objects and eating non-food items like toys and soil.

Because children depend on adults for risk identification and management decisions, ATSDR is committed to evaluating their special interests in the Highway 36 Corridor. In this PHA, children were identified as the most vulnerable to health problems caused by pesticides. OHA has designed conclusions and recommendations that, if followed, will protect children from these potentially dangerous chemical exposures.

Community Concerns

This section of the report describes Highway 36 community concerns related to forestland and agricultural pesticide applications, chemical exposures, and the EI. Understanding community health concerns related to a site or environmental contamination is an important component of the public health assessment process and ATSDR's overall mission. It is important to gather this information early and continuously through the investigation process [6]. ATSDR embraces the philosophy that community involvement requires earnest, respectful, and continued attention. Furthermore, ATSDR believes that one of the keys to the success of the public health assessment process lies in the ability to establish clear expectations, communicate effectively, and place the community at the center of its response [6]. A community's perspective provides a vital link to science by ensuring that our work is relevant.

The term "community" as used in this section of the report includes individuals who reside in the investigation area. However, because of the dynamic nature of social interactions individuals may belong to multiple communities at any one time. A person may be a member of a community by choice or by virtue of their innate personal characteristics, such as age, gender, race, or ethnicity [47]~~[43]~~. Therefore, when initiating community engagement efforts, we make every effort to be aware of these complex associations [48]~~[44]~~, and be inclusive of all individuals who identify as being a member of a given community. This inclusiveness is important for understanding prevailing attitudes, beliefs, actions, and concerns that help to inform and improve our work.

For this section of the report, OHA evaluated qualitative data from several sources. In environmental public health, qualitative information helps public health practitioners understand the daily lives of people in the community in order to:

- learn about a community's history;
- focus on community priorities;
- understand how to best respond to community concerns;
- determine how people may be exposed to potential environmental contamination;
- identify the most effective ways to reduce potential exposures;
- communicate in relevant, inclusive, and equitable ways; and
- ensure the diversity of a community's perspective is represented [49]~~[45]~~.

Table 16 describes the sources of qualitative data we evaluated in this report. Because of the dynamic nature of social interactions and the lengthy history of both industrial chemical use and anti-pesticide activism in this area of the coastal mountains, we have included relevant information that may extend beyond the eight township-ranges that encompass the investigation area.

The community concerns section is not a sociological study, nor does it substitute for the report's conclusions. The purposes of this section are to:

- convey what we have learned is important to the community,

- understand the best ways to provide balanced and objective information, and
- assist with understanding the problems, alternatives, opportunities, and/or solutions.

OHA values, documents, and responds to community input as part of its public health assessment process. Listing or documenting a concern does not mean that we are verifying it as a fact, nor does it indicate our intent to address it with a specific recommendation. We also recognize that the information presented here is not an exhaustive list of concerns. Community members and the public will have an opportunity to review and comment on this section during the public comment period in order to ensure accurate representation.

Table 16: Qualitative data used in this Exposure Investigation.

Qualitative data sources	Types of data included	Usefulness
Participation	Meetings - internal & external, providing assistance, engaging in outreach, encouraging feedback, developing involvement approaches	Establishes relationships, builds rapport & promotes transparency with community; enhances ability to represent community's perspective in the investigation; uncovers assumptions
Observation	Visits and interactions with community, field notes, reflections, community meetings, filmed events, social media	Discovers the multiple communities within the investigation area & the complex set of community dynamics
Interviews, correspondences & conversations	Phone calls, visits to individual homes, conversations at community meetings, emails, correspondences and letters	Uncovers and describes community members' perspectives on events
Review of Documents	News stories, blogs, journal articles, agency documents, reports, community gathered qualitative data, editorials, speeches, pamphlets, newsletters, books, announcements	Documents experiences, values and beliefs of the community; useful in understanding and describing community dynamics; places EI into geographic and historical context
Videos, films & photographs	Community-submitted video, documentaries and photographs; YouTube videos documenting community meetings and gatherings; social media	Discovery; validation of community's experiences; provides information from non-replicable, unique events
Historical analysis	Oral testimonies, life histories, historical records, past events, contemporary records, legal records, statutes, public reports, advocacy group work, demonstrations, reports of eyewitnesses	Discovery; establishes a context for and enhances credibility of community concerns; re-examines questions & assumptions

Qualitative data sources	Types of data included	Usefulness
Questionnaires & surveys	Recruitment and pesticide use questionnaires, urine sample collection surveys	Provides direct answers to specific questions about community knowledge, actions, food sources, activities, time spent outdoors, occupation & hobbies

Analysis of qualitative data

OHA staff reviewed substantial amounts of information in the form of comments, questions, emails, phone calls, historical and legal documents, media articles, videotaped events, observations during public meetings, and other qualitative information sources. OHA grouped this information into four major categories, or themes, based on content analysis. These four themes are:

1. Past and current exposures to pesticides from local pesticide applications
2. Health concerns reported by community members that they attribute to local pesticide applications
3. Psychological, emotional, and social stress
4. Inadequate protection of public health

The following sections describe each of these themes in more detail.

1. Past and current exposures to pesticides from local pesticide applications

Community groups living in and around Oregon's coastal mountain range have raised concerns about the chemicals used in forestland management for several decades. While this EI is focused on chemicals used in both forest and agricultural practices, the predominant community concerns raised throughout the years by members of the community relate to the aerial spraying of pesticides. Historical and legal documents dating back to the 1960s have documented aerial applications of chemicals, including dioxin-contaminated 2,4,5-Trichlorophenoxyacetic acid (2,4,5-T) [50]~~[46]~~, on forestlands, pastures, and rights-of-way in the coastal mountains. In 1979, EPA issued an emergency order suspending the use of 2,4,5-T and Silvex after documenting high miscarriage rates among women living near Alsea in Oregon's coastal mountain range [51]~~[47]~~. Some people who currently live in the investigation area were involved in these early efforts to stop aerial pesticide applications and continue to document their experiences. Some residents report being unaware of local pesticide application practices before moving into the area.

The investigation team heard many community members' concerns about their personal health, the health of their children, and the health of their animals and the environment. Some of these residents moved to the area intending to live and farm organically. They express frustration and anger about their inability to take action to protect their families and farms from alleged chemical drift. They also are angry that any amount of chemicals used in forestry practices were found in their urine. Some community members report moving to the area to retire, but have either left or are considering the option of moving away to avoid the seasonal sprays, which they find intolerable. Some parents are upset and angry that the pesticide imazapyr was detected in the local school's drinking well water after the land above the school was clear-cut and treated with pesticides, which included imazapyr. Families in the investigation area have reported postponing having children and others worry their children will suffer from future health effects.

There are residents who have spent a great deal of time and money in an effort to understand the area's unique geographic conditions and cool moist climate. These residents have surmised that pesticides applied to the steep slopes of the mountains are drifting down into the valleys where they live. They believe pesticide drift is threatening crops grown by farms and vineyards in the area. They assert that the area's climate, which is conducive to fog formation, causes pesticides to "re-volatilize" (or vaporize repeatedly from the soil to air). They contend that the re-volatilized chemicals travel down from the application sites to the valleys where most of the residents live.

While we have heard and documented these concerns, it is important to note that other community members report having no health concerns related to local pesticide application practices. These residents claim they have not experienced health effects from pesticide applications in spite of having lived and worked in the area for generations. Some residents report that they have never missed a day of work due to illness. Many of these community members are timber owners, farmers, and ranchers who use traditional methods of weed control, including the use of pesticides. One resident explained that if an aerial application were planned for an adjoining property, they would sometimes ask the applicator to fly over their property and spray a segment of their land.

This group of residents wants to continue having pesticides available as tools to control noxious, invasive, and unwanted vegetation. They see this controversy as a private-property rights issue. Many of these community members have stated they view anti-pesticide efforts as an invasion of their personal rights to manage their own land. Some of these residents have reported feeling harassed and intimidated by neighbors who are opposed to the use of chemicals. They are worried about possible legal action if they use chemicals on their own farms and timberlands, and have modified their land use decisions in response to these fears. These community members have said they hope the EI will lay the issue to rest, and are worried about ongoing conflicts with their neighbors and within their community.

The third and potentially largest segment of the community does not identify with either of the two positions taken by their fellow community members. Nonetheless, they are affected by the conflict generated by these opposing views. They have said they are interested in the findings of the EI and express support for efforts to learn if exposures may be occurring from local application practices. They also express concern about the ongoing conflict within their community.

2. Health concerns reported by community members that they attribute to local pesticide applications

Some area residents have reported and documented their own health issues and those of their friends, families, and neighbors. They assert that their illnesses and conditions correspond with the seasonal pesticide applications. In the absence of systematically collected health outcome data (i.e., from disease registries) these residents have reconstructed events on their own and have concluded that there are an unusual number of health problems in this area. The health issues reported by these residents include miscarriage, birth defects, congenital disorders in children, and rare cancers in teenagers and young adults.

Pesticide-related health conditions are difficult to diagnose because many of the known symptoms cannot be distinguished from other common illnesses. Most doctors are not trained to identify these conditions. It is very difficult to link environmental exposures of any kind to a specific health outcome in an individual, especially when there is a great deal of uncertainty about the nature of the exposure. In the Highway 36 community, there are uncertainties about whether and how people are being exposed to pesticides from local application practices, and the extent of any exposures. There also are uncertainties about the multiple chemicals used in pesticide applications and their singular and combined health effects, especially on developing babies, children, and the reproductive system.

Below is a list of human health effects attributed by community members to seasonal pesticide applications:

- miscarriages
- birth defects
- stillborn babies
- infertility
- endocrine disorders
- abnormal menstruation
- rare cancers in teenagers and young adults
- other more common types of cancer
- rashes, sores and other skin ailments
- cysts
- cardiovascular effects: tightness in the chest, difficulty breathing, heart arrhythmia, heart attacks, stroke
- weakness, muscle cramps and spasms, joint pain
- moodiness, depression, anxiety, fear, stress and aggression
- PTSD (Post-Traumatic Stress Disorder) and ongoing traumatic stress disorders
- Parkinson's Disease
- burning/itchy/sore/dry eyes, nose and throat
- inability to concentrate, loss of memory, headaches
- Attention Deficit Disorder
- asthma, coughs
- stomach and intestinal ailments, nausea
- porphyria
- chemical sensitivity
- auto immune disorders
- hair loss
- kidney Failure

There are other people living in the investigation area who have not had any health problems associated with forest pesticide applications. They express confusion and skepticism about why others in the community report being sick and unwell. While several of these people express concern about the reports of illness, they also express concern that these reports may be blown out of proportion.

3. Psychological, emotional & social stress

Psychological stress and its associated health effects are well-documented in communities living with real or perceived chemical contamination [52]~~[48]~~. People who are unwillingly exposed to chemicals often experience anger, fear, irritability, uncertainty, and worry over the possible health effects of their exposures. People in these situations report feeling helpless and less secure within their homes and communities. Over time, this stress can lead to major depression, chronic anxiety, or post-traumatic stress disorder (PTSD), and physical changes such as increased blood pressure, increased heart rate, and changes in stress hormones [52]~~[48]~~.

It is not uncommon for conflict to arise within communities where reports of environmental exposures are under investigation. The divisions described above that are occurring within the Highway 36 community mirror conflicts identified in other such communities. These conflicts indicate a breakdown in social cohesion, which is an important protective factor and source of support for individual and community health.

Residents in the Highway 36 area have documented or reported many of the symptoms associated with psychological stress. Residents have stated in public meetings and to agency staff that they are experiencing hostility, fear, and a loss of community cohesion. Residents describe a pervasive climate of suspicion about the intentions of fellow community members, government agencies and industry. During the course of the EI, several themes related to stress have emerged, including:

- Fear and anxiety about:
  - their health and the health of their children
  - possible contamination of their property and the health of their animals and wildlife
  - their personal safety, including intimidating gestures, outbursts, and threats of violence
- Frustration and anger
- Feelings of mistrust
- Alienation from neighbors or former acquaintances and the erosion of social support

The following sections describe these themes in more detail.

Fear and anxiety:
Much of the fear and anxiety expressed by some community residents is related to the still-evolving scientific understanding of the effects from low-dose chronic exposures to pesticides and the uncertainties about the long-term health consequences. Some express deeply held beliefs that any amount of contamination is unacceptable. These community members are concerned that chemicals used in the investigation area are endocrine disruptors, for which there is a great deal of scientific uncertainty.

In the face of these uncertainties, some community members draw upon their own knowledge, beliefs, and values to develop a personal interpretation of their overall risk, and seek out others whose interpretations are similar to their own [53]~~[49]~~. Several advocacy groups have emerged within the Highway 36 community that represent opposing viewpoints on the use of chemicals, in particular the aerial spraying of chemicals. This has become a polarizing issue. The differing beliefs and interpretations about risk and exposure reflect, and may contribute to, social conflict within the community.

There are also concerns that some of these groups receive assistance and resources from organizations outside of the investigation area. This perceived interference by outside interests has amplified community divisions. All of these dynamics contribute to the overall levels of stress within the community, and make it more difficult for people to cope with real or perceived chemical contamination [54]~~[50]~~.

The investigation team has heard repeated claims that it is a person's "right to know" where and when applications will occur near their homes, and what chemicals have been or will actually be used. Community members have reported more stress and anxiety during spray seasons because they cannot get this information prior to actual pesticide applications. They seek this information so they can leave the area when applications occur and avoid potential exposure. At the same time, they express frustration that they must take these actions to protect themselves.

Several community members pay a fee of $25 a year to receive ODF's application notifications as a way to anticipate where and when applications will occur.[18] Community members have voiced their frustration with this notification system, and have reported the following issues to the investigation team:

- The fee is a hardship.
- Notifications are not available electronically.
- The period within which applications may occur is not specific (applications can occur between 15 days to 12 months after the notification is submitted).
- The chemicals listed include what could potentially be used, not what will actually be used.
- Handwritten notifications are sometimes illegible.
- Notifications are difficult to understand.
- The forms are not standardized, and they do not collect the same information from every applicator.
- Many of the notification forms are not fully filled out.
- Several notifications are sent at one time in a packet through the mail for a five-section or square mile area.
- Notifications include a topographical map without context for the larger geographic area.
- Subscribers are not given notice when their subscription is up for renewal.
- Once a subscription has lapsed, there is no way to obtain notifications for the lapsed period of time.
- There is no way to notify subscribers of modifications or changes to a particular notification once it has been sent to the subscriber.
- If a landowner requests a waiver for any notification requirements, subscribers are not informed about why the waiver was requested or if one was granted.

Personal Safety:
There is a history of mistrust and community conflict in the coastal mountain range. This conflict stems from divergent views on forest practices, property and human rights, land use and the environment, and differences in personal beliefs and lifestyles. This history is relevant because some community members who oppose the use of pesticides have expressed fear of retribution based on historical events. Some of this ongoing fear for personal safety originates from events that occurred in the 1970's that they witnessed or heard about from others. Historical and legal documents have described harassment of anti-pesticide activists by government agencies and industry. These include allegations of "suspicious house fires, cars that were rigged to explode" [55]~~[51]~~, and in one case involving a noted activist, being "harassed by aircraft flying dangerously low and, in the case of the helicopters, hovering and circling for extended periods of time" [56]~~[52]~~.

[18] Under ORS 527.670(8), ODF provides copies of notifications and written plans for designated areas to interested persons who pay the required fee. In addition, under ORS 527.670(6), ODF provides such information on a non-fee basis to persons with downstream surface water rights, if such persons request that service in writing.

Other residents report feeling intimidated by the approaches used by activists who are opposed to pesticide use. Some people have expressed fear that they will be sued or harassed for using chemicals on their property. Helicopter pilots and activists alike have reported or documented threats to their personal safety. The EI team has observed aggressive and intimidating gestures and language from both sides during public meetings or on recorded tapes and videos.

Frustration and Anger:
Residents express anger at many things, including: Oregon's Right to Farm and Forest Law; the Forest Practices Act (FPA); the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA); timber companies; pesticide makers; the chemical industry; trade lobbying organizations; environmental organizations; ODA; ODF; PARC; and the EI.

Community members have expressed frustration over having to navigate a complex system of governmental oversight in order to understand how to effect change. Some believe the law favors the economic interests of large industrial landowners more than it protects people's health. Other residents are frustrated and angry about letters they received from lawyers who were hired to prevent them from using chemicals on their own property. There are disputes and litigation between neighbors over allegations of chemical drift, economic and business losses, and property devaluation.

Mistrust and alienation:
Many community members have expressed some degree of mistrust and skepticism about industry's influence on the regulation of pesticides and on the EI. Some specific concerns related to the regulation of pesticides include:

- the chemical and timber industries' degree of influence over public policy relating to the regulation, application, and use of pesticides;
- the government's process for determining whether risks to human health are adequately understood and used to inform pesticide use laws; and
- the validity of research used to support claims of chemical safety and inform requirements for pesticide labeling and use.

Community members have also expressed skepticism about the EI, including concerns about the following:

- The EI lacks independence and scientific rigor. Community members are concerned that the EI will be unduly influenced by community activists who are intent on eliminating access to pesticides or by trade lobbying groups who are intent on ensuring continued access to the use of pesticides.
- The EI is an unwarranted expenditure of public funds.
- The resources needed to complete the investigation will be reduced or eliminated, or that industrial landowners have, and will continue, to thwart the investigation by using chemicals that cannot be tested for in urine.
- The EI is not inclusive enough of community input, does not allow community as an equal stakeholder, and is not doing enough to stop the spraying until the extent of human exposure is known.

4. Inadequate protection of public health

As pointed out, there is a wide range of viewpoints regarding aerial spraying and the use of pesticides within the Highway 36 community. Some people are confident that EPA's pesticide labeling and risk assessment process is protective of health. Others are skeptical and want the government to do more to protect their health. Some community members have proposed establishing aerial spray buffer zones around homes and schools, while others want a complete moratorium on all uses of pesticides.

Most community members express some degree of appreciation for the agencies' investment in their community and support for the investigation efforts. Some of these community members are comfortable with the initial, baseline EI conducted by ATSDR, are not concerned about exposures and question why the investigation continues. Others are frustrated with what they see as a delay in acting to prevent exposures they believe are occurring during each spray season.

Residents seeking a change in application practices express one or more of the following concerns or positions:

- Government agencies are not doing enough to protect private citizens' health.
- Existing environmental regulations are based on a risk assessment process that does not adequately protect human health and the environment.
- As science advances, pesticides will be found to be more harmful than previously thought.
- Government is not taking community concerns seriously, and they feel like "guinea pigs".
- The "Precautionary Principle"[19] should be invoked by placing a moratorium on some application practices (specifically aerial spraying) until these practices are proven safe.

In an effort to address their own health concerns, a few residents have taken steps to hire a forensic agronomist, test their own drinking water, collect and have their urine samples analyzed, and pay for air monitoring equipment and analysis. These residents want to know how pesticides move and act in the unique climate of the investigation area. In an effort to capture this information, they have educated themselves on the science of air and water monitoring and agronomics.

Summary

OHA believes that stress and community conflict in the investigation area negatively affects both individual and community health and well-being. This dynamic may impede future efforts to understand and respond to community concerns about pesticide exposures. The issue of pesticide use in general, and aerial applications in particular, has created conflict between neighbors and friends. One resident said that people who used to be friendly have stopped talking to her. Others have expressed their apologies to the investigation team for what they call embarrassing behavior - behavior they feel reflects poorly on their community. Many people have made it clear they do not know who to trust or what to believe. This type of polarization within rural communities is arguably more destructive and stressful than in more populated areas because people in rural areas or smaller communities may be more dependent on each other's relational resources and community capacity [57]~~[53]~~.

[19] The Science and Environmental Health Network describes the Precautionary Principle as follows: "When an activity raises threats of harm to human health or the environment, precautionary measures should be taken even if some cause and effect relationships are not fully established scientifically."

OHA has identified several causes of stress and conflict within the Highway 36 community, including the following:

- fear and anxiety about personal health, safety, and children's health;
- differing views on pesticide use and human and private property rights;
- ongoing concerns about the lack of adequate notifications and records of pesticide applications;
- anger and distrust of government agencies; and
- divisions within the community and existing social networks.

These stressors negatively affect individual community members and the Highway 36 community as a whole. OHA believes that formal mediation services may help to reduce community stress and improve community cohesion in the longer term. Mediation may also be necessary for the successful completion of the EI.

Progress Toward Answering Investigation Questions

Table 17 describes the EI team's progress toward answering the original EI questions. The table also highlights outstanding gaps in available information and identifies the types of activities that would help fill these information gaps. OHA drew from information gaps identified in this table to guide recommendations and the public health action plan.

Table 17. Summary of the Exposure Investigation Questions and Progress Toward Answer

Exposure Investigation Question	Progress Toward Answer	Conclusions	What else is needed to answer the question?
Are residents in the Highway 36 Corridor being exposed to pesticides or herbicides from local application practices?	• Fall 2011 sampling was designed to capture baseline conditions when known pesticide applications were minimal. As expected, overall results of fall 2011 sampling confirm that exposures to 2,4-D and atrazine were low among Highway 36 investigation area residents during the fall season. • Community-collected data from Spring 2011 indicate that exposures to 2,4-D and atrazine were occurring in Spring 2011.	1. This investigation did find evidence that residents of the investigation area were exposed to pesticides or herbicides in spring and fall 2011. While not possible to confirm that these observed exposures occurred as a result of local application practices or were from other sources, the evidence suggests that local applications that occurred near to and at the time the nine 24-hour subset samples were collected in spring 2011 may have contributed to the concentrations of pesticides detected in participants' urine.	Additional biologic testing, conducted to coincide with the timing and location of aerial application of pesticides that can be detected in urine would provide important evidence regarding the relationship between known applications of pesticide and detectable levels in local residents.
	If residents are being exposed:		
To what pesticides or herbicides are they being exposed?	• Spring and Fall 2011 urine data indicate that Highway 36 investigation area residents were exposed to 2,4-D, and Spring 2011 urine data indicate that residents were exposed to atrazine in the spring. • Fall environmental sampling indicates that exposure to pesticides other than 2,4-D was	2. Residents in the Highway 36 investigation area had urinary biomarkers for exposure to 2,4-D in spring and fall 2011, and atrazine in spring 2011. We were unable to determine if tested residents in the investigation area had urinary biomarkers for exposure to pesticides other than 2,4-D	Additional laboratory methods that allow for measurement of other pesticides in urine would enhance OHA's ability to answer this question.

Exposure Investigation Question	Progress Toward Answer	Conclusions	What else is needed to answer the question?
	minimal. • The inability to measure pesticides other than 2,4-D and atrazine in urine is a significant technical limitation.	and atrazine in spring or fall 2011. 3. Some Highway 36 investigation area residents may have been exposed to very low levels of DEET, fluoridone, or hexazinone in their drinking water during the fall of 2011 time-period. 4. Some Highway 36 investigation area residents may have been exposed to very low levels 2,4-D or glyphosate in their soil. 5. Some Highway 36 investigation area residents may have been exposed to very low levels of clopyralid in the air.	
To what levels are they being exposed?	• Fall 2011 urine data indicate that Highway 36 investigation area residents were exposed to low levels of 2,4-D at that time. • Spring 2011 urine data indicate that Highway 36 investigation area residents were exposed to levels of 2,4-D statistically higher than in the general U.S. population at that time and higher levels of both 2,4-D and atrazine in Spring than in the Fall.	6. In the spring of 2011, Highway 36 investigation area residents had higher levels of 2,4-D exposure than the general U.S. population. 7. In the fall of 2011, Highway 36 investigation area residents had urinary 2,4-D levels that were not statistically higher than the general U.S. population. 8. In the spring of 2011, urine	

Exposure Investigation Question	Progress Toward Answer	Conclusions	What else is needed to answer the question?
		samples from Highway 36 investigation area residents also had detectable levels of atrazine, but it is unknown how these levels compare to the general U.S. population.	
What are potential source(s) of the pesticides or herbicides to which they are exposed?	• ~~Baseline~~ Pre-application, ~~S~~spring 2011 urine results and pesticide application records data indicate that there are likely other sources of 2,4-D and atrazine exposure in Highway 36 investigation area residents that have not yet been identified with existing resources. • The nine ~~Twenty~~24-~~four~~-hour subset of ~~spring 2011~~ urine samples collected in spring 2011, and four pesticide application records ~~data~~ indicate that there ~~is~~ may be an association between local pesticide applications and statistically significant increases in urinary atrazine metabolite levels.	9. There is insufficient information to confirm that local pesticide applications are the source of pesticides found in the urine of participating Highway 36 investigation area residents. However, there is evidence to suggest that some local aerial applications may be a contributing source of human exposure.	Additional information about non-regulated uses of 2,4-D and atrazine and environmental persistence would help to answer this question more fully. OHA will need continued access to pesticide application records data to accompany any future monitoring efforts.
What are potential routes (pathways) of residents' exposures?	• Fall 2011 environmental sampling ruled out drinking water, soil, and homegrown foods as routes of exposure for~~at~~ that specific time-period. • Community-collected environmental sampling from ~~S~~spring 2011 ~~were~~ was insufficient	10. We were unable to determine if air was a potential pathway of exposure to pesticides in the Highway 36 investigation area. 11. Drinking water can be eliminated as an exposure pathway for the 2,4-D and	Widespread passive air monitoring before and during a pesticide application season, coupled with analysis for the appropriate pesticides, would provide valuable

Exposure Investigation Question	Progress Toward Answer	Conclusions	What else is needed to answer the question?
	to rule out any exposure routes for that time-period. • Lack of air monitoring data during the fall and spring pesticide application seasons represents a significant data gap. Without this air monitoring data, exposure via ambient air from either direct drift or volatilization cannot be ruled out.	atrazine detected in Highway 36 investigation area residents' urine. 12. Soil sampled in the fall of 2011 can be eliminated as an exposure pathway for the 2,4-D and atrazine detected in Highway 36 investigation area residents' urine. 13. Homegrown food sampled in the fall of 2011 can be eliminated as an exposure pathway.	information about whether or not ambient air is an important exposure pathway for Highway 36 investigation area residents.
What health risks are associated with these exposures?	• Urinary 2,4-D levels in Fall and Spring of 2011 were below toxicity-based BEs, indicating that measured 2,4-D levels are not associated with health risks. • OHA cannot conclude whether or not atrazine metabolite levels measured in Highway 36 investigation area residents'[2] urine in Spring 2011 could harm people's health because there is no toxicity-based threshold value for atrazine in urine against which these measured levels can be compared.	14. The levels of 2,4-D measured in Highway 36 investigation area residents' urine in spring and fall 2011 were below levels expected to harm people's health. 15. We cannot determine whether the levels of atrazine metabolites measured in Highway 36 investigation area residents' urine in spring 2011 could harm people's health. 16. Drinking or contacting domestic water with pesticides at the concentrations detected in	BEs for additional pesticides, especially atrazine metabolites, would greatly enhance OHA's ability to make health determinations based on urinary pesticide concentrations. RfCs for pesticides in ambient air will be very helpful in evaluating air monitoring data collected in the future for health

Exposure Investigation Question	Progress Toward Answer	Conclusions	What else is needed to answer the question?
		some Highway 36 investigation area properties is not expected to harm people's health. 17. Contact with soil with pesticides at the concentrations detected in the fall of 2011 in some Highway 36 investigation area soil is not expected to harm people's health. 18. Handling or consuming garden vegetables, berries, eggs, milk or honey from the Highway 36 investigation area from fall 2011 will not harm people's health.	significance.

Conclusions

As a result of this EI, OHA reached *twenty-two* important conclusions addressing the questions about the presence, type and source of exposure to pesticides in the Highway 36 investigation area:

OHA reached *one* conclusion related to the question: **Are residents in the Highway 36 Corridor being exposed to pesticides from local application practices?**

> **Conclusion 1:** This investigation did find evidence that residents of the investigation area were exposed to pesticides or herbicides in spring and fall 2011. However, it was not possible to confirm if these observed exposures occurred as a result of local applications practices or were from other sources.

OHA reached *four* conclusions related to the question: **To what pesticides are they being exposed?**

> **Conclusion 2:** Residents in the Highway 36 investigation area had urinary biomarkers for exposure to 2,4-D in spring and fall 2011, and atrazine in spring 2011. We were unable to determine if participants in the investigation area had urinary biomarkers for exposure to pesticides <u>other</u> than 2,4-D and atrazine in spring or fall 2011.
>
> **Conclusion 3:** Some Highway 36 investigation area residents may have been exposed to very low levels of DEET, fluoridone, or hexazinone in their drinking water.
>
> **Conclusion 4:** Some Highway 36 investigation area residents may have been exposed to very low levels 2,4-D or glyphosate in their soil.
>
> **Conclusion 5:** Some Highway 36 investigation area residents may have been exposed to very low levels of clopyralid in the air.

OHA reached *three* conclusions related to the question: **To what levels are they being exposed?**

> **Conclusion 6:** In the spring of 2011, Highway 36 investigation area residents had higher levels of 2,4-D exposure than the general U.S. population.
>
> **Conclusion 7:** In the fall of 2011, Highway 36 investigation area residents had urinary 2,4-D levels that were not statistically higher than the general U.S. population.
>
> **Conclusion 8:** In the spring of 2011, urine samples from Highway 36 investigation area residents also had detectable levels of atrazine metabolites, but it is unknown how these levels compare to the general U.S. population.

OHA reached *two* conclusions related to the question: **What are potential source(s) of the pesticides to which they are exposed?**

Conclusion 9:
There are additional sources of 2,4-D and atrazine in the investigation area that are not accounted for in the pesticide application records available to the investigation team.

Conclusion 10:
Statistical associations suggest that four local aerial applications of atrazine and 2,4-D to forestland may have contributed to an increase in urinary atrazine metabolite levels in samples collected from nine ~~samples~~ participants ~~collected~~ within 24 hours of those applications.

OHA reached *five* conclusions related to the question: **What are potential routes (pathways) of residents' exposures?**

Conclusion 11: We were unable to determine whether air is a pathway of exposure to pesticides in the Highway 36 investigation area.

Conclusion 12: Drinking water was eliminated as an exposure pathway for 2,4-D and atrazine in the fall of 2011.

~~**Conclusion 13**: Concentrations of pesticides in drinking water in the spring of 2011 and other seasons and years are unknown.~~

Conclusion ~~14~~13: Soil sampled in the fall of 2011 was eliminated as an exposure pathway for the 2,4-D and atrazine detected in Highway 36 investigation area residents' urine.

Conclusion ~~15~~14: Wild or homegrown food products sampled in the fall of 2011 were eliminated as an exposure pathway in fall of 2011.

Conclusion 1~~3~~5: Concentrations of pesticides in drinking water, soil and homegrown food in the spring of 2011 and other seasons and years are unknown.

OHA reached *five* conclusions related to the question: **What health risks are associated with these exposures?**

Conclusion 16: The levels of 2,4-D measured in Highway 36 investigation area residents' urine in spring and fall 2011 were below levels expected to harm people's health.

Conclusion 17: We cannot determine whether the levels of atrazine metabolites measured in Highway 36 investigation area residents' urine in spring 2011 could harm people's health.

Conclusion 18: Drinking or contacting domestic water with concentrations of pesticides detected in some Highway 36 investigation area properties in fall 2011 is not expected to harm people's health.

Conclusion 19: Contact with soil containing pesticides at the concentrations detected in the fall of 2011 in some Highway 36 investigation area soil is not expected to harm people's health.

Conclusion 20: Handling or consuming garden vegetables, berries, eggs, milk or honey collected from the Highway 36 EI participants' homes in fall 2011 will not lead to harmful health effects related to pesticide exposure.

OHA reached *two* additional conclusions related to the impacts to the EI and to the health of community members from community conflict.

Conclusion 21: Divisions and hostility within the community~~,~~ related to ~~land use,~~ pesticide use, ~~and~~ property rights and land use~~,~~ are creating significant stressors on many individual community members and on the community as a whole.

Conclusion 22: Leadership activity within the community has been oriented toward debating issues of land use, pesticide use, and property rights. No formal or informal leader has yet emerged who has a mediating influence on these differences. Formal mediation services for the Highway 36 community may be necessary for both the successful completion of the EI and for the important progress needed to reduce community stress and improve community cohesion in the longer term.

Recommendations

Pertaining to the results of this EI, OHA recommends that:

1. US EPA work with the EI team on developing a sampling and analysis plan designed to evaluate exposures to pesticides in air and to address gaps in the data needed to answer EI questions. At the time of publication of this report, passive air monitoring over several application seasons appears to be the best option to collect community-wide air data.
2. ODA and ODF continue to provide pesticide application data as needed to interpret air sampling (or other) data collected as part of this investigation.
3. State and federal agencies involved in the ongoing EI develop an implementation plan that includes identification of necessary resources to carry out activities appropriate for each agency's role in this effort.

Pertaining to broader and/or longer-term issues identified by the EI, OHA recommends that:

1. State agencies continue to collaborate on determining best practices that would protect human populations from pesticide exposures.

~~1.~~2. ODA and ODF work with pesticide applicators to develop consistent pesticide application record-keeping processes to ensure that application record data are accurately maintained and usable.

~~2.~~3. State agencies explore the feasibility of implementing a system that would allow ~~sensitive populations~~people to be notified of imminent pesticide applications in such time and with such specificity that they could take action to avoid exposure to those applications. Such policies could include adoption of systems developed by other jurisdictions, or modification of existing regulatory systems designed to monitor pesticides applications.

3. ~~State agencies collaborate on determining best practices that would protect human populations from inadvertent pesticide exposures from aerial applications.~~
4. State and federal agencies involved in the ongoing EI develop an implementation plan to address these recommendations, including the identification of resources to carry out activities appropriate for each agency's role in serving the communities of Oregon. That plan should include a recommendation on how the agencies should coordinate, collaborate and share resources.
5. Community members, including local elected officials and other community leaders, consider seeking the assistance of a professional mediation group to address immediate and long-term conflict within the community and identify actions to move this conflict toward resolution.

Public Health Action Plan

Public health actions completed:

- The EI team collected urine and environmental samples in fall 2011, and communicated individual results back to EI participants in winter 2011/2012.
- The EI team hosted two public meetings (July 2011 and April 2012) and one open house (November 2011) in Blachly, Oregon.
- ATSDR released a report on the fall 2011 urine sample results in March 2012.
- OHA led outreach activities for the EI, including recruiting participants, coordinating three community meetings and one open house, conducting surveys and questionnaires, determining chain of custody for the community-collected urine samples, and developing ~~the development of a~~the Highway 36 EI web page and listserv, press releases, flyers,~~a~~ factsheets, and other communication materials.
- Since 2011, OHA has participated with ODF, ODA, and DEQ on the Water Quality Pesticide Management team, which serves as the scientific advisory committee for the Pesticide Stewardship Partnership Program aiming to reduce pesticide movement into waters of the state.
- OHA's ~~has long been the~~role as co-chair of PARC, has been to provid~~eing~~ a public health perspective on appropriate responses for human pesticide exposures in Oregon.
- OHA tracks acute pesticide exposures in Oregonians as part of its Pesticide Exposure, Safety and Tracking program (PEST). The EPA Office of Pesticide Programs reviews ~~and~~ the ~~F~~findings from PEST (along with other states' surveillance programs), ~~of this program are reviewed by the EPA's Office of Pesticide Programs~~ when determining updates to pesticide labels.

Public health actions planned:

OHA will:

- Work with state and federal partners, community members, and other stakeholders to implement the recommendations in this report.
- Provide updates through the Highway 36 web page and listserv about findings from:
  - The comparison of application records from 2011 to application records from 2009 and 2010 to determine if there were noticeable (substantial) changes in pesticide application practices after the EI was initiated in 2011.
  - Air sampling data once it is collected by the EPA.

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Report Preparation

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Appendix A: Response to public comments

This appendix describes how EHAP addressed and/or incorporated public comments into this final report of the Highway 36 Exposure Investigation Public Health Assessment. OHA received comments from 52 individuals, community groups, industry representatives and legal teams. Some comments were very extensive.

Since many comments contained multiple topics, we grouped statements together that were similar in nature. We have presented many comments verbatim, to minimize the chances of miscommunicating or misinterpreting the comment. In cases where two or more comments expressed the same question or concern, we paraphrased them for clarity.

OHA does not list names or affiliations with these comments, in order to protect the commenter's identity. In some cases, we have left names in a comment, when a group or company refers to itself within the comment. Each comment is numbered, and OHA's response follows in italics.
Visit www.healthoregon.org/ehap to access all (redacted) comments received by OHA.

Comment 1: "It is incomprehensible how the agency could avoid concluding that forestry aerial sprays were the source of the atrazine metabolites found in residents' urine. The only documented use of atrazine in the study area was in forestry aerial sprays, and urine levels tested shortly after aerial applications of atrazine showed significant increases above earlier levels, as documented in the draft report. Atrazine is a Restricted Use Pesticide, making it highly unlikely that residents in the study area use it on their property in any way."

Response: Many commenters made similar statements. In response - and based on additional analysis, OHA has revised conclusion 9 and added a new conclusion 10 to clarify the findings. Conclusion 9 is now focused on the evidence that there were additional sources of atrazine (and 2,4-D) not accounted for in the application records available to OHA. Based on what we now know, the 13 spring samples that were collected before any known pesticide application, contained levels of urinary atrazine metabolites (and 2,4-D) that were similar to the 26 samples collected at varying times after known applications (Table 10). In other words, all 39 spring 2011 samples had statistically higher levels than the fall 2011 samples, including those 13 spring samples that were collected before any known application.

In addition, OHA developed a new conclusion (#10) that identifies four aerial applications of 2,4-D and atrazine as likely contributors, in whole or in part, to the statistically higher atrazine metabolite levels in the nine 24-hour subset samples. The nine, 24-hour subset samples are those that were part of the original 39 spring samples, but were collected within 24 hours of a nearby spray. When compared to the other 30 spring samples, these nine subset samples contained statistically higher levels of atrazine metabolites.

However, in order to confirm that aerial sprays or ground applications are the actual sources of this statistical difference, OHA would need also to have simultaneous environmental sampling data to detail how atrazine persisted and traveled from the application sites to the nine participants' locations. This difference between the nine 24-hour subset urine samples and the other 30 spring 2011 urine samples could also be influenced, at least in part, by temporary changes in the amounts of pesticides released by *unknown source(s) of atrazine and 2,4-D that were taking place at the same time. These sources have not been identified in currently available application records.*

Comment 2: "Determination of 'Biological Equivalency (BE)'
The Interim PHA was unable to compare atrazine results with a bio-monitoring equivalent (BE) because there is not a BE for atrazine. However, information on derivation of the BE for atrazine and its metabolites was discussed and submitted by ~~Syngenta~~ [redacted] (September 21, 2011) to the OHA, Oregon Department of Agriculture, Oregon Department of Environmental Quality, ATSDR and EPA Region 10. Information on derivation of an atrazine BE was based on the extensive atrazine database and by application of a Physiologically Based Pharmacokinetic (PBPK) model. An Excel spreadsheet-based Forward- and Back-Calculator tool was provided."

Response: OHA appreciates the provision of these resources. However, OHA is constrained to use publicly available, peer-reviewed resources to evaluate locally collected data.

Comment 3: "Based on the PBPK model, the urine detections in samples taken by some community members in spring 2011 are not plausible. Samples were taken to purportedly represent "pre- and post-spraying" and assumed passive exposure via air or water. As indicated in ~~Syngenta's~~ [redacted] September 21, 2011 submission, atrazine is rapidly metabolized, predominately to diamino-chloro-s-triazine (DACT), within hours of exposure. Furthermore, worker exposure studies have clearly characterized likely urine concentrations of DACT after known levels of exposure. This knowledge, together with atrazine's low vapor pressure and the application of the Calculator render the results from the 2011 "pre-spray" samples as unrealistic."

Response: OHA places confidence in measured data over modeled predictions. Regardless of how these data may appear, they represent actual measurements, and the investigation team is tasked with explaining those measurements to the best of our ability. In addition, DACT was the primary metabolite measured in spring 2011 urine samples, which is consistent with previous studies mentioned in the comment.

Comment 4: "The report does not document the use of adjuvants (various additives) that were applied concurrently with pesticides. These products, which are not subject to the same labeling requirements as active ingredients, are used for a variety of purposes, including making the product stick to vegetation, reducing foam, and reducing drift. Many of these products are considered toxic in their own right, yet OHA did not examine their use in the study area."

Response: This is a limitation of the investigation. Application records do not require that applicators include specific chemical identities for adjuvants. The ODF records do require that applicators list product names for adjuvants, but not the specific chemicals in the products. Typically they were described as "surfactants," "dyes," and "defoamers." This level of information is insufficient to determine what specific chemicals to test for in the environment or in urine in the Highway 36 Corridor. Without exposure data, it is impossible to evaluate the risk to human health.

ODA's record keeping requirements apply only to pesticides, not adjuvants. ODF explained that their requirements obligate applicators to record the brand name (product name) of all chemicals, including adjuvants in their application records. ODF explains:

"An ODF compliance assessment against Forest Practices Act (FPA) standards found compliance rates at or above 90% for recorded pesticide application locations, listed pesticides and operation start/end dates. The compliance rate for recording adjuvant information was 89%. While the audit indicates areas with lower compliance, the records do provide valid data on what products were applied, where and when. Education and outreach efforts have already begun to clarify expectations of pesticide application record contents, including an update to the pesticide application form (see http://www.oregon.gov/ODF/privateforests/pages/pesticides.aspx), and will continue into 2014."

Comment 5: "The OHA draft report contains total amounts for various pesticides, but using two different units, pounds and gallons, based on the pesticide formulation used. Then in Table 19, colors are used to indicate which pesticides were used the most. That table indicates that hexazinone was the pesticide used the most in the study area in 2011. It is possible to convert the liquid chemicals from gallons to pounds by using the density or other information contained on the product's label or MSDS (Material Safety Data Sheet).... Thus, the application records provided by ODF show that forestry accounted for over 9 tons of pesticide products applied in the Triangle Lake Study Area during the year 2011. It is also clear, after converting the products to the same units, that hexazinone was not the most heavily used pesticide in the watershed. In fact, atrazine was the most-used pesticide in the watershed, followed by glyphosate, then 2,4-D, then imazapyr, and only then hexazinone. It should also be noted that while the amounts of metsulfuron methyl and sulfometuron methyl applied were relatively small, that the application rates for these two chemicals are far lower than the other chemicals used."

Response: OHA acknowledges that information about the amounts of pesticides applied is presented in mixed units, as they were received by ODA and ODF. The total and relative amounts of pesticide applied are pieces of information that are tangential to the exposure investigation. OHA's focus is human exposure relative to the toxicity of the active ingredients. Because some active ingredients are more toxic than others, absolute amount applied relative to other active ingredients is not a relevant measure of human health risk.

Comment 6: "In reviewing all of the pesticide application records provided by ODF, I found that of the 244 records provided, at least 65 (27%) lacked one or more of the items of information required by ODF rules for pesticide applicators on forest land. That is a dismal compliance rate, and has clearly affected the ability of investigators to accurately determine what products were applied, when, and where."

Response: ODF responded, "An Oregon Department of Forestry (ODF) compliance assessment comparing Forest Practices Act (FPA) standards found compliance rates at or above 90% for recorded pesticide application locations, listed pesticides and operation start/end dates. The lowest compliance rate was observed with the requirement to record the carrier type (69%). Most of the described applications were suitable for a water carrier and applicators probably did not consider that water needed to be listed as a carrier. As stated in a previous comment, the audit indicates there are areas with lower compliance. However, the records do provide valid data on what products were applied, where and when. Education and outreach efforts have already begun to clarify expectations of pesticide application record contents, including an update to the pesticide application form (see http://www.oregon.gov/ODF/privateforests/pages/pesticides.aspx), and will continue into 2014."

Comment 7: Multiple commenters independently obtained pesticide application records from ODF. Some of these commenters identified discrepancies between the numbers of records they obtained and the numbers obtained and reported by OHA.

Response: OHA has been in communication with these commenters and ODF. OHA has resolved these discrepancies and this final report accounts for all application records. The numbers of unique application records counted by independent commenters and OHA now match. This application record information is in Appendix B. None of the additional application records occurred during urine or environmental sample collection in the fall or spring of 2011 or contained either of the pesticides tested in urine samples.

Comment 8: "There are two errors in the chart on page 33 showing the Siuslaw Watershed Guardians' water quality testing results. Both are in the column showing the results for Hexazinone:
a. In the first row, showing the result for the original sample at Fish Creek near the Mouth, the amount of Hexazinone per POCIS should be 64 nanograms, not the 50.7 that is shown. The lab report shows 192 nanograms in the sample; therefore, the correct entry should be 192 divided by 3, or 64.
b. In the sixth row, showing the result for the original sample at Nelson Creek downstream of Almaisie Creek, the amount of Hexazinone per POCIS should be 13.6 nanograms, not the Not Detected that is shown. The lab report shows 40.8 nanograms in the sample; therefore the correct entry should be 40.8 divided by 3, or 13.6."

*Response: OHA made these corrections in this final version of the report. See page 36 [*Table 14*].*

Comment 9: "The OHA report indicates, at page 32, that the Oregon Department of Environmental Quality 'typically' finds atrazine and hexazinone in waters throughout the state. However, a review of sampling sites used by DEQ shows that these detections have typically been in larger streams draining much larger watersheds that typically contain many land uses, including agriculture. The sampling sites used by the Siuslaw Watershed Guardians were, with the exception of the Lake Creek sampler, sites on very small streams draining very small watersheds where forestry is typically the primary land use."

Response: OHA altered the text in the report to reflect that DEQ's typical atrazine detections by POCIS sampling are from larger streams draining multiple land use types including agriculture (See page 35).

Comment 10: "Other potential sources of pesticides in the watershed which have not been investigated include Triangle Lake itself (water, sediments), as well as air-borne contaminants released when treated lumber is burned."

Other comments stated that limited environmental sampling has led to uncertainties about pesticide exposures.

Response: It is true the investigation team has not sampled Triangle Lake or other surface waters aside from Little Lake. When treated lumber is burned, the pesticides are destroyed and so would not become a source of contamination. OHA acknowledges that environmental sampling data are limited and that conclusions of the report are limited to the available data. Given limited resources, environmental sampling was prioritized to characterize those pathways with the greatest potential for the largest exposures.

Comment 11: "The POCIS sampler that was located in Lake Creek above Fish Creek showed detections of Atrazine, Desethyl Atrazine and Hexazinone, but the pesticide application records show that there were no prior applications of those chemicals in the watershed above the sampling point. This is strong evidence that the contamination occurred through drift from pesticide applications in adjoining watersheds."

Response: This is one line of evidence that pesticides can travel some distance from the application site. Other evidence is referenced in the report (Page 31). However, without quantitative information about ambient concentrations in the media (i.e. air, water, soil) that people are exposed to, it is difficult to know the potential impact of this movement on the health of people in the area.

Comment 12: "On page 4 of the draft report, OHA makes the following statement: 'This investigation documented the presence of 2,4-D and atrazine in the urine of residents. There was a drop in those levels between the spring and fall 2011 for reasons that are currently unknown.' This statement is very hard to understand, given that the application records examined by OHA show very clearly that atrazine and 2,4-D were applied aerially in the spring but were not applied at all in the fall. Table 19 on page 64 of the draft report shows no applications of either of these chemicals after May (although another section of these comments show that there was an application of 2,4-D in June which had been mislabeled by ODF and was therefore overlooked by the OHA). The reason for the drop in atrazine and 2,4-D in urine levels is obvious: the timber industry uses these chemicals only in the spring. It is extremely puzzling why OHA could not draw that very obvious conclusion. Maintaining a rigorous scientific study does not require abandoning logic and common sense."

Response: The 13 pre-application samples from Spring 2011 make it difficult to simply conclude that the lower levels in fall 2011 are the result of no recent timberland applications. There were also no application records showing use of 2,4-D or atrazine in the several months leading up to these 13 samples, yet the 2,4-D and atrazine metabolite concentrations in these 13 samples were significantly higher than fall 2011 samples.

Comment 13: "The original investigation design, as described on page 16 of the draft report, was to include urine sampling before and after nearby ground or aerial spraying in the spring of 2012. However, as explained on page 23 of the draft report, the spring sampling was suspended on March 8, 2012, 'because the areas that were slated for applications of 2,4-D and/or atrazine were in remote locations which have very few residents.' On page 7 of the draft report, OHA states that 'It is not known if the Exposure Investigation resulted in changes to pesticide application practices in the investigation area, and therefore if exposure conditions have changed for Highway 36 corridor residents.' In fact, the pesticide application records provided by ODF for the years 2009 through 2011 document very clearly that for all three years, atrazine and 2,4-D were heavily applied in the study area during the spring. The records document that the following amounts of 2,4-D and atrazine were applied in the study area for the years 2009 through 2011: (see Table 2 in second tab). Application records from 2012 are not available; however, according to the OHA report, no sprays of 2,4-D or atrazine were planned for the spring for the study area. This is totally contrary to the pattern, which is clearly established by the records for 2009 through 2011, showing heavy use in the study area of atrazine and 2,4-D in the spring. Thus it seems fairly clear that the timber companies in the study area changed their practices by avoiding the use of

2,4-D and atrazine (the only two chemicals which OHA can test for in urine) and instead using other chemicals in their place."

Response: OHA did not have the resources to enter and analyze pesticide application records for 2009-2010. Analyzing trends of pesticide use over time is a task we have slated for a future report as the investigation continues as mentioned in the "Public Health Action Plan" in the summary section and on page 58. Your comments and work will give us a head start as we begin that process, and they are much appreciated.

Comment 14: "I urge those in charge of this investigation to expand the study area to include all of the state, and to redesign the study in such a way that the timber companies and pesticide applicators will not know when or where samples are being taken. I urge those in charge to invest appropriate resources so that adequate air, water and biological samples can be taken that will provide answers rather than simply raise more questions. I urge those in charge to pursue air testing for all chemicals used on forest and agricultural lands in Oregon, and to conduct such tests in adequate numbers that conclusions can be drawn."

Response: The investigation team does not have the resources to expand this investigation beyond the current area. However, if the EPA is successful in developing and deploying passive air samplers in the investigation area, they could be used in other areas of the state as well. EPA and DEQ will coordinate this work. EPA's efforts are focused on developing passive samplers that would capture the active ingredients currently used in forestry. Passive samplers would allow for monitoring over time without coordination with landowners.

A major difficulty in designing urine sampling without coordinating with landowners is that samples have to be collected within 24 hours of an application. Without knowing exactly when an application is to occur, it is logistically challenging to collect samples within that 24-hour window.

Comment 15: "OHA continues to use "pesticide" data when herbicide-specific data is available. The synergistic effects alluded to are generally with much more toxic insecticides. Available evidence on herbicides used in combination finds more antagonistic combinations than synergistic. And the worst-case scenario was only a multiple of two times toxicity (see Acute Toxicity of Commonly Used Forestry Herbicide Mixtures to *Ceriodaphnia dubia* and *Pimephales promeias*," Environmental Toxicology 27(12): 671-684). The claim of "potentially greater risk" overstates available information and appears to bias what is known about the health effects of herbicides."

Response: The field of toxicology is making advances in understanding the effects of complex mixtures. However, this area of study is still young and is associated with a lot of uncertainty. Where uncertainty exists, it is the role of public health agencies to err on the side of caution. The text of the report does not claim that there is greater risk, only that there is potential for greater risk. Another area of uncertainty is that the complex mixtures in question are not simply multiple herbicidal active ingredients, but also includes multiple adjuvants. Application records do not specify what chemicals are used as adjuvants. When confronted with these unknowns, OHA is constrained to assume that some additive or even synergistic mixture effects are possible.

Comment 16: "On page 21 and 23, the PHA concludes that only two commercial applications of pesticides occurred prior to the urine sampling on August 30 and 31, and that these were ground pesticide applications. However, according to the official spray records obtained by ~~Beyond Toxics~~[redacted], one aerial spray took place on 8/18 and three aerial sprays took place 8/28-29. OHA did not do urine testing for the chemicals used in late August, 2011, nonetheless, it is important to include the full data set in the report."

Response: The section of the report mentioned here states that these were the only applications occurring during the sample collection – not prior to application. The 8/18 application was considered too early to have had a bearing on sampling results, and as indicated, it did not include either 2,4-D or atrazine. However, OHA agrees that the 8/28-29 aerial applications were close enough to the sample collections to warrant mentioning in the report, and they have been added to the section where this is discussed (Page 23). As noted, none of these four applications included 2,4-D or atrazine, so they would not have influenced urine results for these two pesticides.

Comment 17: "The OHA draft report mentions, but does not discuss, the possibility of volatilization of pesticides as a possible source in the study area. A recent study by the U.S.D.A.'s Agricultural Research Service indicates that under certain conditions, more pesticide product can be lost to volatilization than to surface runoff. (*Comparison of Field-scale Herbicide Runoff and Volatilization Losses: An Eight-Year Field Investigation*, Timothy J. Gish, John H. Prueger, Craig S.T. Daughtry, William P. Kustas, Lynn G. McKee, Andrew L. Russ and Jerry L. Hatfield, Journal of Environmental Quality 2011 40: 5: 1432-1442doi:10.2134/jeq2010.0092.) The study showed that revolatilization is significant when ground moisture is high and temperatures are increasing, the exact conditions in Oregon in the spring. A prepublication version of this study is included as Exhibit F."

Response: OHA agrees that volatilization is an exposure pathway that has not been adequately addressed to this point. It is mentioned in Table 1 (page 17) as a potential exposure pathway. Table 17 (page 50) mentions that volatilization cannot be ruled out as an exposure pathway and that air monitoring is needed in order to determine whether or not it is a significant pathway of exposure in the Hwy 36 area. ~~OHA agrees that conditions in the Hwy 36 area are consistent with those most likely to lead to volatilization in the cited paper. This is why~~ OHA has recommended that EPA develop and deploy passive air monitoring devices that can be used to determine concentrations of herbicides in ambient air. Passive air sampling will not, in itself, allow us to differentiate volatilization from drift, but pesticide application records covering the period of monitor deployment can be used in combination with passive monitoring results to distinguish them.

Comment 18: "Parts of the Interim PHA mischaracterize the toxicological & human health data base for atrazine. Appendix E uses two short paragraphs to describe the extensive toxicological database for atrazine and does not adequately represent the current state of knowledge on atrazine. Several statements in Appendix E can be taken out of context if not taking into account environmental exposures. The Joint FAO/WHO Meeting on Pesticide Residues (JMPR) conducted a toxicological evaluation of atrazine in 2007 and published it in 2009. The JMPR states that 'The database on atrazine was extensive, consisting of a comprehensive set of GLP-compliant guideline studies with atrazine and its four key metabolites, as well as a large number of published studies' and 'investigations of other modes of action did not provide any evidence that atrazine had intrinsic estrogenic activity or that it increased aromatase activity in vivo' (WHO, 2009)."

Response: It was not OHA's intention for Appendix E (now appendix F on page 126) or any other portion of the PHA to serve as a comprehensive literature review for atrazine. Readers are referred to ATSDR's Toxicological Profile on atrazine for a more detailed and complete review. The PHA does not claim that atrazine causes cancer, though it does document some community members' concerns that it might. The PHA also does not claim that atrazine is intrinsically estrogenic. However, the extensive toxicological record on atrazine clearly demonstrates disruption of other endocrine pathways and interference with reproduction in animal models. These highly reproducible and consistent findings demonstrate that atrazine is an endocrine disruptor and that at sufficient doses can and does impair reproduction and cause developmental toxicity in animal models. As with all toxicological questions, actual risk depends on the dose.

Comment 19: "In 2010, the atrazine drinking-water guideline prepared for the Third Edition of the WHO Guidelines for Drinking-water Quality was revised following the 2008 publication of the 2007 Joint FAO/WHO Meeting on Pesticide Residues (JMPR) evaluation of atrazine and its environmental metabolites (WHO, 2008) http://www.fao.org/docrep/010/a1556e/a1556e00.HTM.

Based on the 2007 JMPR review, the Guideline Value of 100 ppb was derived for the sum of atrazine and its chloro-s-triazines in 2010 (WHO, 2010) http://www.who.int/water_sanitation_health/dwq/chemicals/dwq_background_20100701_en.pdf."

Response: As the agency regulating public drinking water safety in Oregon, OHA uses the current Maximum Contaminant Level (MCL) enforced by the EPA. This MCL is currently 3 ppb.

Comment 20: "Limited information provided in Appendix E fails to represent the comprehensive toxicological database on atrazine, and is solely "hazard" based, thereby ignoring potential exposures based on relevant environmental concentrations. PHA Question 2 (e) asks, "What health risks are associated with these exposures?" Scientifically valid data on both hazard and exposure are required to conduct an appropriate characterization of potential risk associated with atrazine. http://www.epa.gov/risk_assessment/basicinformation.htm#risk."

Response: See response to comment 18 regarding limited information in Appendix E (now Appendix F).

OHA has added a sentence to the end of the first paragraph on atrazine in Appendix E (now Appendix F) stating "As with all chemical exposures the severity and risk of health effects depends on a person's actual dose."

Toxicity values for atrazine are based on administered dose (e.g. EPA's oral reference dose or ATSDR's Minimal Risk Level). In the absence of a biomonitoring equivalent (BE), OHA was not able to quantitatively compare measured concentrations of atrazine metabolites in urine to an oral dose. Without this comparison, it was not possible for OHA to determine which of the potential health effects of atrazine may correlate to these measured exposures in the investigation area. For these reasons, OHA was unable to conclude whether or not measured atrazine exposures in Hwy 36 area residents could harm their health.

Comment 21: "On page 1 of the draft report, it is stated that community collected urine, water and air samples were analyzed by privately contracted analytical laboratories at Emory University in Atlanta, Georgia. That statement is correct only regarding the urine samples; the air and water samples were analyzed by Anatek Laboratories in Moscow, Idaho. On page 62 of the draft report, the paragraph between the figure and table summarizes Table 18, but fails to mention the 18 documented roadside applications of pesticides. It should also be noted that most of these roadside applications were done on private timberland by industrial timber companies."

Response: OHA corrected these errors in this final version of the PHA.

Comment 22: "The OHA report mentions only briefly the potential synergistic effects of combinations of pesticides such as the frequent combinations of 2,4-D and atrazine used aerially in the study area. So-called "tank mixes" are very common for both ground and aerial sprays, as the application records document clearly. Another combination of four pesticides (glyphosate, imazapyr, metsulfuron methyl and sulfometuron methyl) is frequently applied in the study area, sometimes in combination with additional adjuvants such as methylated seed oil."

Response: The investigation summarized in this report was subject to several limitations, chief of which was the available data on which to base conclusions. Concerns for the health effects of pesticides alone or in combination are understandable. However, in our work we are held to rigorous standards of scientific evidence so that conclusions drawn can be defended. We were only able to test for 2,4-D and atrazine individually and the possible human health effects of specific amounts of these two chemicals in combination is unknown. Gaps in the data are unsatisfactory to all parties, and a valid cause for concern. The Highway 36 / Triangle Lake Exposure Investigation should be seen as one step in a process of effective and appropriate scientific inquiry to protect the health of the community. The scope of OHA's involvement in future efforts is in the Public Health Action Plan section of the document. Recommendations of this report outline efforts led by other agencies.

Comment 23: Many commenters expressed concern about OHA's treatment of the statistical difference between the urinary 2,4-D levels of fall 2011 EI participants and the general U.S. population 75th percentile (p-value 0.06 in Table 3). Some commenters said it was inappropriate for a state agency to use phrases like "approaches statistical significance," claiming p-values are designed to be objective, binary pass/fail tests. Other commenters said that OHA should call a p-value of 0.06 close enough to be statistically significant, arguing that additional factors should be weighed considering significance of the result.

Response: In all fields of study, the numerical value at which statistical significance is declared is a threshold set by "alpha"; this corresponds to the probability that the results would occur 1-alpha percent of the time if the scenario were repeated many times. Most fields of study accept an alpha of 0.05 (95% confidence level that the results would repeat) as a conservative measure of statistical significance; however, some fields of study will consider and report alphas of 0.10 corresponding to a 90% confidence level. Many fields of study choose to report findings of alphas less than 0.05 as significant and alphas between 0.05 and 0.10 as marginally significant, as we have here.

The p-value in itself simply describes the probability that a given result could have occurred by random chance. In this case, there is a probability of 0.06 or 6% that the observed difference between EI *participants and the general U.S. population could have happened by random chance and a 94% chance that the difference between the two groups is a true difference and not random. In other words, if we repeated the sampling 100 times, we would expect true differences 94 of those times. Language in the report has been altered to reflect that the distribution of urinary 2,4-D in the two populations (EI participants and the general US population 75th percentile)is somewhat different.*

In summary, the difference between distributions of urinary 2,4-D concentrations in EI participants in fall 2011 and the general U.S. population appear to be slightly different in the upper quartile. There are more EI participants within the upper quartile of the expected range than would be expected. In other words, EI participants were still within the expected range as defined by 95th percentile of NHANES, just distributed at the higher end of the range.

OHA changed language in the report to clarify significance levels (see page 20). OHA also changed language to clarify that the range, as defined by comparing 95th percentiles of El participants and NHANES, is as expected and that the distribution within that range may be different (as measured by a marginally significant p-value=0.06) when comparing 75th percentiles.

Comment 24: "The Oregon Health Authority also opted to exclude a child, under six years of age because 'there are no NHANES values for comparison for children under six years old. We believe that OHA should include this child and reevaluate the statistical significance of the presence of 2,4-D in participants' urine. Had OHA included this child, then the p-value of the 75th percentile finding would likely have been statistically significant, i.e., <0.05. We request that OHA review its analysis and determine whether inclusion of this participant creates a statistically significant finding."

Response: OHA could not include the two children younger than six years in the analysis for the report itself for the reasons stated. However, OHA did test for significance with the two additional children included. Under these conditions, the p-value went below 0.05 indicating statistical significance for the comparison of Highway 36 residents to the NHANES 75th percentile. The p-value for the comparison of Highway 36 residents to the 95th percentile did not approach significance. Thus, the overall conclusions related to the comparison of fall 2011 urine samples to NHANES would not have changed even if the two children had been included. See response to Comment 23 for more discussion of statistical significance and meaning of p-values.

Comment 25: "On page 22 of the report under "Summary of Fall 2011 Sampling", the second bullet point states that: "[B]ecause statistical significance tests on urinary 2,4-D levels were equivocal, OHA cannot conclude whether EI participants were statistically different than the general U. S. population with respect to urinary 2,4-D levels at the time of sampling." This assertion is contradictory to the actual analysis of the data summarized on pages 17-18. Comparisons to the NHANES 90th percentile show that "this number was not higher than expected". Even when the results were compared to the arbitrary 75th percentile, the numbers were not statistically significant. The 2,4-D concentrations from the fall 2011 sampling show that the numbers are what should be expected for any like population in the United States. That is what the report should reflect."

Response: Statistical tests do not indicate EI participants' samples were higher than the general population at the time of sampling. Comparing NHANES 75th percentile with EI participants provided *a p-value=0.06; this suggests, with 90% confidence, that the distribution of EI participants levels in the upper quartile may differ from the general population. Together these results suggest that individuals in the EI population did not show statistically higher 2,4-D levels than the general population; however, individuals may be more likely to have levels in the high end of the expected range. Language in the report (page 20) has been changed to clarify the difference between statistically higher levels (or range) and statistically different distributions.*

Comment 26: "This report suggests that landowners deliberately changed application practices because of the investigation. This accusation should have some basis if it is to appear in the report. Contrary to the assertion made here, a review of application records show no major changes in application practices after the El began. The assessment implies that forestry landowners have not acted in good faith regarding the investigation, and that is simply not true. This statement should be backed up with data or removed from the report. This section of the report highlights the lack of understanding about forestry operations that has been a persistent issue throughout the Highway 36 Exposure Investigation. We encourage OHA to better engage with forestry landowners and the Oregon Department of Forestry to gain a better understanding of how our private forestlands are managed. After repeated attempts to explain our industry, OHA appears either unwilling or unable to accept that spray timing and constituents are not fixed."

Response: The statement referenced in the PHA is an acknowledgement that OHA understands pesticide application timing and constituents are not fixed and that last minute decisions are made based on needs on the ground at the time of application. The statement does not attribute motives to this fluctuation in practices, though it does assume that changes in practices are deliberate, in that they are not accidental.

OHA has not yet reviewed application records from years prior to 2011 or in 2012. OHA does plan to do this analysis as part of the ongoing exposure investigation as described in the Public Health Action Plan section. If the commenter is willing to share their analysis of application records with OHA, this will help expedite the process. ODF is a partner in the exposure investigation and as such, has had multiple opportunities to clarify forest practices and provide input on this report.

Comment 27: "This report fails to address the many potential pathways of exposure and makes the assumption that it is likely caused by spray drift from aerial applications. This conclusion [Conclusion 10 on pages 5 and 55] is not justified by the sample results. The 2011 fall urine samples determined that 92% of the participants had detectable levels of 2, 4-D (of which all were below levels expected to harm people's health) However, the report does not address the fact that 2, 4-D was not aerially applied in this same time period. How can one conclude that the source of exposure is spray drift when 2, 4-D was not even aerially sprayed in the preceding months? Conclusion 9 of the report states there is "insufficient information to confirm that local pesticide applications are the source…. However, available evidence suggests it is possible". Where is this evidence?"

Response: See response to Comment 1 for updates on revisions to Conclusion 9 and the new Conclusion 10. The information referenced in this comment is now addressed in Conclusion 10 of the final report. Conclusion 10 cites the statistically significant increase in spring 2011 urinary atrazine metabolite levels in the nine samples collected within 24 hours of known aerial applications of 2,4-D and atrazine. Given that atrazine is a controlled substance whose use must be reported, these four aerial applications *were the most likely sources contributing to the observable increase in urinary atrazine metabolite levels for those nine 24-hour subset samples.*

The spring 2011 urine samples had overall generally elevated concentrations of 2,4-D and atrazine metabolites and many of them (13) were collected prior to any known applications for the year. This indicates that additional sources of these pesticides in the community exist that cannot be explained by the application records data available to OHA.

Comment 28: "I think that the PHA should recognize that any rural farming or forestry populations are going to have greater exposure levels than US urban populations to these compounds. If the comparison base was stratified for this bias, I did not see it in the PHA."

Response: The NHANES data used as a representation of the general U.S. population may have an urban bias, however, it is the only dataset available for use as a reference point for the U.S. overall. It is not possible to stratify these data by parameters that would separate urban from rural subpopulations.

Comment 29: "By treating the Highway 36 Investigation as an isolated incident, the PHA fails to assess the overall risk of pesticide exposure and how the increase of that risk is related to Oregon's forestry chemical policy."

Response: OHA understands that many of the climate, topography, and land use patterns at play in the investigation area are not unique in Oregon. However, the State does not have the resources to expand the investigation beyond its current geographical scope.

Comment 30: "We encourage PARC to continue to study the effects of pesticide/ herbicide applications in the forested rural Oregon, making an effort to:

a. include larger sample sizes to gain statistical significance
b. establish adequate scientific measures to test the air
c. obtain accurate chemical applicator records including private applicators
d. investigate research into the impact of pesticide/herbicide impact on human health including research in addition to EPA data, and evidence of the synergistic effect of multiple and chronic chemical exposure for both adults and children
e. study long term health data for residents in rural forested areas"

Responses:

a. OHA currently does not have the resources or capacity to test larger numbers of affected community members
b. EPA is developing methods and equipment for testing air quality relative to ambient pesticide concentrations
c. The records that ODF, ODA, and OHA have requested and reviewed include private chemical applicators. Private applicators are also required to keep application records and supply them when requested.
d. See response to comment 22 and 32
e. A long-term health study is beyond the scope of this exposure investigation. An academic institution would be best suited to seek special funding for and implement a long-term health study.

Comment 31: "On page 23, the PHA states that 'eight of the thirteen known ....pesticide applications that occurred during fall 2011 ... used Glyphosate.' However, according to the official spray records obtained by ~~Beyond Toxics~~[redacted], there were thirteen instances of Glyphosate use. (See table)"

Response: The referenced statement in the PHA only applies to applications from both forestry and agricultural sources that occurred on the days EPA and DEQ were collecting environmental samples (Sept. 19-22). The referenced table provided by this commenter listed seven forestry applications that occurred outside of the Sept. 19-22 period and did not include two agricultural applications that did occur during that period.

Comment 32: Many commenters attached or provided links to peer-reviewed studies that supported evidence showing low-dose chronic exposure to atrazine can cause harmful health effects. The comments claim these studies and materials indicate that current toxicity thresholds are not protective of public health, especially for children. Based on conclusions of submitted materials, commenters urged OHA to conclude more definitively that the level of exposure documented in Highway 36 Corridor residents has harmed, is harming or will harm their health or the health of their children.

Other comments state that the PHA understated the margins of safety built in to the toxicity threshold values used to evaluate exposures in terms of public health risks.

Response: OHA reviewed the materials submitted by commenters. There is a wide variety in findings, quality, and relevance of materials provided. Some of the materials submitted to OHA consisted of research papers describing effects on wildlife (e.g. frogs), and it is difficult to know how relevant those effects are to human health. Other submitted materials described effects observed in vitro (looking at cells in isolation in a petri dish), and it is difficult to predict how changes seen in vitro will translate into a complex, living human being. Toxicologists use in vitro studies to determine which outcomes to look for in animals or humans. Sometimes those outcomes are found in animals or humans, and often times they are not. Because predictions based on in vitro studies often do not translate into observed changes in animals or people, they cannot be used on their own to support toxicity thresholds. Other submitted articles described epidemiological studies in humans where atrazine exposure was statistically associated with specific health outcomes in humans. This report already references some of those epidemiological studies. EPA and ATSDR have regular review schedules for atrazine. Epidemiological studies published before the last review would have already been considered in existing toxicity threshold values. Epidemiological studies published after the last review will be considered in the next round of review for atrazine.

OHA cannot develop its own threshold values, as the time and cost is prohibitive. OHA relies on the EPA and ATSDR to determine appropriate toxicity threshold values.

Toxicity threshold values represent doses, including large safety margins, of a given chemical below which no human health effects are expected over designated lengths of exposure. EPA has an oral reference dose (RfD) for atrazine (35 μg/kg-day) which applies to chronic exposure over a lifetime and was designed to be protective of sensitive populations including children. ATSDR also has an oral minimal risk level (MRL) for atrazine that applies to acute or short-term exposures lasting less than 2 *weeks. This acute MRL is 10 μg/kg-day. ATSDR also has an MRL for oral exposure to atrazine lasting longer than 2 weeks but less than 1 year. This intermediate MRL is 3 μg/kg-day.*

One common thread for all of these toxicity thresholds is that they are expressed in terms of an oral dose delivered per kilogram body weight per day. Given that none of the environmental sampling (drinking water, food, soil) for this EI found atrazine at detectable levels, it is impossible to estimate an oral exposure that could be compared against these toxicity thresholds. Community sampling found atrazine metabolites in urine. However, there are no currently available methods (public or peer-reviewed) to estimate an oral exposure that could be compared to these toxicity thresholds based on a concentration in urine. Therefore, OHA is not able to compare measured concentrations of atrazine metabolites in urine against any toxicity thresholds, which would support conclusions about health effects related to the measured atrazine concentrations in urine.

Comment 33: Several comments expressed concern that the toxicity information on 2,4-D and atrazine that the government uses relies too heavily on industry-funded studies. These comments suggest that industry-funded studies could be influenced by a conflict of interest. The argument presented by commenters is that the companies selling these products have a vested financial interest in obtaining study results that indicate that their products are safe so that they can continue to sell them.

Response: While OHA understands and acknowledges this concern, it is beyond the scope of OHA's ability to address it. In addition to industry-funded studies, EPA also considers information provided from other sources such as the findings of researchers at academic and scientific institutions who study the toxicology of pesticides, as long as those studies meet appropriate data quality requirements. ATSDR establishes its MRLs using the same or similar information. To assure impartiality and data quality, the conduct of these studies is subject to strict controls, and there are steep penalties for conduct not in-line with these controls. It is the EPA and not OHA that audits these studies and enforces those controls.

Comment 34: "The PHA fails to address the fact that 2,4-D was detected in urine samples of 92% of the residents tested in fall 2011, despite that fact no 2,4-D was used in forestry or agricultural applications during the fall, with the last reported 2,4-D spray occurring in May 2011. It is unlikely that 92% of the residents used any 2,4-D products in the fall months, particularly since many of the residents do not use any pesticides on their residential property. The PHA should add a discussion as to whether 2,4-D may be more persistent in the environment than previously reported, might have a longer urinary half-life than previously reported, or that 2,4-D exposures might be from residual environmental exposures. The report should make recommendations about future investigations to better understand the fate of 2,4-D in a forestry ecosystem and to understand how the (latent) exposure is occurring."

Response: The fall 2011 urine samples indicate that 2,4-D exposure during that time period were within the expected range for anywhere in the United States. In the most recently released NHANES report, at least 50% of the sampled population had detectable levels of 2,4-D, and the sampled population was skewed towards urban environments where 2,4-D exposure is expected to be lower than in rural environments. OHA expects that the frequency of 2,4-D detection will continue to increase across the country, not so much as a function of increased 2,4-D exposure but rather as a function of chemists' abilities to detect smaller and smaller amounts of 2,4-D. None of the environmental samples collected for the EI (soil, water, food) explain where the urinary 2,4-D in fall 2011 samples came from. Because

2,4-D passes through the body within 24 hours and only lasts a few weeks in soil, 2,4-D would have been expected in soil, water, or food if those were the sources of the 2,4-D in urine.

Comment 35: Several commenters expressed concerns about the validity of community-collected urine samples based on gaps in the chain of custody. The predominant concern is that the gap in the chain of custody could have provided community members opportunity to tamper with their samples by either adding atrazine-containing pesticides to their urine samples after they had been produced or intentionally exposing themselves to atrazine.

Response: The portion of the chain of custody that was missing for some samples did not occur until after samples had been delivered to the loading docks at Emory University. All samples had complete chains of custody from the time the samples were collected at the health clinic until they were shipped from the clinic to Emory University (as explained on page 27 of the report). In order for a community member to have used the existing gap in the chain of custody to tamper with their sample, they would have to have been physically present at Emory University in Atlanta, Georgia when the samples arrived at the loading dock, intercepted them between the time university mail services picked them up from the dock and dropped them off at the researcher's laboratory, resealed the packages, and delivered them to the researcher's laboratory. This scenario is so unlikely that it cannot be viewed as a credible possibility.

Alternatively, participants could have brought pesticides containing atrazine with them into the clinic restroom where they produced their sample and added the pesticides before handing them to clinic staff. This is very unlikely because adding an atrazine-containing pesticide to a urine sample would have resulted in high concentrations of parent atrazine detected in the samples. In fact, no parent atrazine was detected in any of the urine samples. Only DACT and other metabolites of atrazine were detected. This indicates that the parent atrazine had passed through a living body and into the urine samples.

It is possible to purchase the detected atrazine metabolites online, but to add them to the urine samples in the expected ratios, as they were detected, would have required considerable skills in chemistry and sophisticated methods of measurement and the ability to distribute this knowledge to all of the participants. This scenario is extremely unlikely, and it cannot be viewed as a credible possibility.

The participants could have intentionally exposed themselves to atrazine before producing their samples, but no chain of custody or method of sample collection or delivery could have prevented this, including OHA's fall 2011 sampling procedure. Concerns about this method of tampering are separate and distinct from concerns about the chain of custody.

Comment 36: Several comments noted conflicting language in the summary portion of the PHA. The introduction to conclusions related to the question "What health risks are associated with these exposures?" stated "…no levels (of pesticides) expected to cause health effects were documented in this investigation." This statement is inconsistent with conclusion 14 (now 16) which states that "We cannot determine whether the levels of atrazine metabolites measured in Highway 36 investigation area residents' urine in spring 2011 could harm people's health."

Response: OHA updated the introductory language to that section of the summary (see page 7)to be consistent with all of the conclusions in that section.

Comment 37: "The basis of the decision for Conclusion 11 [now Conclusion 12] is misleading. Atrazine or 2,4-D were not detected in drinking water samples taken in fall 2011, most likely because neither chemical was used by the commercial pesticide operators since spring 2011. It is possible that spring sampling would find pesticide detections. Thus, drinking water cannot be eliminated as a potential exposure pathway for future exposures."

Response: The objective of our investigation included the determination of exposure pathways for the 2,4-D and atrazine that was found in the residents' urine. When the sampling protocol was developed, the EI team considered the potential for exposure from drinking water and agreed that it was very important to test the drinking water pathway. There was also agreement among the hydrogeologists on the team that if there were no detections in groundwater, this would likely rule out drinking water as an exposure pathway. The key reason for this is that groundwater chemistry tends to be stable and persistent over time. If the chemicals were infiltrating to groundwater in this area, and were transported to the drinking water sources, there would be detections in at least some of the wells. The drinking water sources tested in the fall of 2011 had no detections of 2,4-D or atrazine. Our conclusion with respect to the drinking water pathway was that it is unlikely that atrazine or 2,4-D could have been present at concentrations high enough to cause the observed urine concentrations in the spring of 2011 and then be low enough to be undetectable by fall of the same year. We apologize for not explaining this in our basis of decision in Conclusion 11 (now Conclusion 12).

OHA modified Conclusion 11 (now Conclusion 12) to specify that the elimination of this exposure pathway applies only to fall 2011 when water sampling was done. OHA also added a new conclusion (Conclusion 13) stating that the concentrations of pesticides in drinking water at other times of year and in other years are unknown. Available pesticide application records do not indicate any applications of 2,4-D or atrazine for several months prior to the first thirteen spring 2011 community-collected urine samples that contained 2,4-D and atrazine metabolites. In the unlikely event that 2,4-D or atrazine were in drinking water at that time, the source is unknown.

Comment 38: "Buried in conclusion number 14 is the following statement, 'The levels of 2,4-D measured in Highway 36 investigation area residents urine in spring and fall of 2011 were 'below levels expected to harm people's health.' Rigorous systems are established to register herbicides for use in the United States. Voluminous data are collected and analyzed prior to setting standards for exposure; in this case biomonitoring equivalents for 2,4-D. This conclusion is the definitive finding of the report. It should be presented as a dominant finding and could be more affirmatively stated, for example, '…below levels determined by the EPA to pose any health risks.'"

Response: OHA and partner agencies approached the EI with a set of guiding questions (page 1). OHA expressed conclusions in the same sequence as the questions they answer. The relative importance of the report's conclusions may vary depending on the audience.

Comment 39: A few commenters suggested that some of the exposure pathways in Table 1 should be listed as "completed" exposure pathways rather than "potential" exposure pathways.

Response: For a pathway to be listed as "complete," all five elements of the pathway (source/release, transport in environment, point of exposure, route of exposure, exposed population) have to be known to *exist. In all of the potential pathways listed, there was at least one element of the pathway where there was no data to confirm or rule-out the pathway. Most often, the missing piece of data was in the "transport in environment (media)" element of the pathway. This means there was a critical data element on pesticides in air, water, or soil missing from the pathway. It is also important to note that a pathway exists for individual pesticides. This means that imazapyr in water and 2,4-D in urine, for example, does not constitute a completed exposure pathway because they are different chemicals. Because there was no environmental (air, water, soil, food) data collected in conjunction with spring 2011 urine samples, it is not possible to determine whether any specific exposure pathway is complete for those samples. Again, this is because, for that time period, there are no data for the "transport in environment (media)" element in the exposure pathway (column 3 in Table 1 page 17).*

Comment 40: "If valid air sampling results are obtained, there should be other exposure information for use in any analysis. ~~Syngenta~~ [Redacted] suggests that issues with the Interim Report must be resolved to ensure the best available data is used and that sample design problems are identified to substantiate data reported are of maximum quality."

Response: EPA will be the lead agency on method development, study design, and sampling plans for any future air monitoring. OHA will provide input, but will primarily rely on EPA's expertise.

Comment 41: "Because there is evidence of pesticide/herbicide exposure despite a paucity of data, and because the OHA has expressed a sincere interest in the health of the local residents, we feel one conclusion of this investigation should recommend a moratorium on aerial helicopter applications in the area as a precautionary principle to protect the dozens of residents in the area whose subjective reports, alongside PARC's investigation, point to likely airborne pathways of exposure in the process of elimination. The implicit conclusion that aerial pesticide/herbicide applications are benign until a proven pathway if found, given the extensive first-hand experience, initial urine data, and visual evidence of local residents, is biased towards the status quo, and against common sense and a basic human ethic of care."

Response: To recommend a moratorium on aerial applications, we would need to determine that aerial applications were the actual source of exposure. The evidence collected so far indicates that in spring 2011 some residents were exposed to 2,4-D and atrazine at levels that were higher than normal for the general U.S. population. However, the timing of many of the spring 2011 samples collected was before any known aerial applications (see responses to comments 1 and 12). These samples had elevated levels of 2,4-D and atrazine even though they were collected before any known aerial applications. This indicates that aerial applications may not be the major source of atrazine or 2,4-D found in urine samples. With this uncertainty, we must conclude that the data do not support a moratorium on aerial applications.

Comment 42: OHA received several comments with specific suggestions and input about the study design and sampling plans for future air monitoring and other kinds of environmental monitoring in the EI area. Some of the suggestions include numbers of monitors that should be deployed, where they should be deployed, how long they should be deployed for, and who should know when and where monitors are deployed. Some comments provided detailed plans for water and other environmental sampling.

Response: See response to comment 40. OHA has already provided EPA these comments for them to consider as they design future environmental monitoring methods, studies, and sampling plans.

Comment 43: Some comments requested that OHA work directly with legislative counsel to develop a bill that would establish a notification system that would allow residents necessary information about timing and location of pesticide applications to be able to leave the area if desired.

Response: OHA has already recommended that partner agencies that are more directly involved with the regulation of pesticides develop or modify a notification system. OHA intentionally kept the language in the recommendation broad, with the ultimate goal of a functional notification system in mind. It may be that the goal can be achieved more quickly without engaging the legislative process. OHA wanted to avoid designating a specific process by which this goal must be achieved, allowing room for innovation and efficiency. OHA does not have enough experience in pesticide use regulation to confidently recommend a specific process or notification system. OHA is available to partner agencies to consult and inform the process as needed.

Comment 44: Several comments expressed that no amount of exposure to pesticides is acceptable, no matter how small.

Response: Every individual chooses whether a level of exposure is acceptable to them or not. As a public agency, OHA is constrained to make determinations about thresholds of toxicity based on science. The weight of scientific evidence clearly demonstrates that toxicity depends on the dose of a chemical received. Even in the case of endocrine disruptors and other types of chemicals with low-dose effects, evidence still suggests that the dose is important. There is a great deal of public debate occurring about whether current testing programs are adequate to capture potential low-dose effects, but most scientists still agree that there is some dose below which no harmful health effects are likely to occur. The reality of life in the developed world is that exposure to chemicals at some level is unavoidable, and as chemists improve their ability to detect lower and lower concentrations of chemicals in the environment we expect to find chemicals where previously we could not.

Comment 45: Several comments expressed concern about the cost of the EI in light of the lack of clear findings of harm to public health. These comments request that the EI be discontinued.

Response: One critical exposure pathway, air, has not yet been fully characterized. It is important to continue the EI until we have a clear picture of the potential for people to be exposed to pesticides via air, from either drift or re-volatilization. The EPA is in the lead of future work on the EI related to air monitoring. OHA will be available to consult and inform EPA's process, but this involvement is not likely to be extensive or costly to the state. OHA has also committed to analyze pesticide application record data from 2009 and 2010 to document trends in application practices over time and to determine whether conditions in 2011 were representative of typical years. OHA will present the results of this analysis along with (i.e. at the same time as) results from EPA's air monitoring.

Comment 46: Several comments expressed concern that additional sampling is needed and that the EI would be discontinued too soon.

Response: See response to 45.

Comment 47: Several comments requested buffer zones around residences and schools where no aerial pesticide applications would be allowed. Suggested buffer zones varied in distance from schools and residences and in the permanence or duration of the use of buffer zones. Some wanted permanent buffer zones, while some wanted temporary buffer zones until air movement from application sites is better understood.

Response: OHA created a new recommendation (page 11) to partner agencies to continue to collaborate to develop best practices to reduce ~~inadvertant~~ exposures to people in the community. Buffer zones may be one of multiple options to address this recommendation.

Comment 48: Several comments suggested that OHA, "Complete a thorough analysis of the pesticide data using spray records data from 2009 through 2013. Look for trends and examine the forestry pesticide practices and human health and environmental data to determine the source of pesticides exposures."

Response: As stated in the response to comment 13, OHA did not have the resources to enter and analyze records from 2009-2010 for this report, but it is on the Public Health Action Plan for additional work on the EI. That additional analysis will be done and released in coordination with additional air monitoring work the EPA is planning. Also, see response to comment 26.

Comment 49: There were several comments that were similar to this one asking OHA to "Perform air sampling and monitoring, and test for biomarkers in accordance with the seasonal cycles of forestry pesticide spray. ~~Beyond Toxics~~[Redacted] has analyzed the seasonal trends and found that Atrazine, 2,4-D, Clopyralid and Hexazinone are typically used in the spring. Glyphosate, Imazapyr, Triclopyr, Metsulfuron methyl and Sulfometuron methyl are typically used in the summer and fall. Fall urine samples should be analyzed for Glyphosate."

Response: Additional air monitoring is in the methods development and planning phases (see response to comment 45 and 26). The second paragraph of the "Suspension of Spring 2012 Sampling" section on page 26 of the report highlights the logistical challenges of additional urine sampling timed to pesticide applications. These challenges make additional urine sampling unfeasible for OHA. While many environmental laboratories have the technical capacity to test for additional pesticides in liquid media, they often lack the necessary accreditation to handle human biological samples. Conversely, public health laboratories that have the accreditation to handle human biological samples often lack the equipment to test for pesticides. The laboratory at the National Center for Environmental Health (NCEH) in Atlanta, GA is one laboratory with the capacity to do both. However, they do not have methods in place to test for glyphosate or any of the other pesticides mentioned in the comment. California and Washington States both have some capacity to test for pesticides in biological samples, but for the most part they house the same methods used at the lab in the NCEH to ensure that their results can be compared against NCEH's reference populations (NHANES). Another challenge to testing for additional pesticides in urine highlighted on page 26 of the report is that having results with nothing to compare them with would have little meaning. Without some reference population or toxicity value, it would be impossible to determine whether measured results (if detected) were high or low compared to other people in the United States or compared against toxicity thresholds. Also, see responses to comment 13 and 45 regarding additional analysis of pesticide application records.

Comment 50: "Detection of pesticides in residents' urine samples indicates the probability that pesticide applications violate registered product labels and present a heightened drift risk. ~~Beyond Toxics~~[Redacted] recommends that the Investigation Team undertake a thorough investigation of aerial forestry spray practices, including height of aerial craft at time of spray, weather, wind, temperature, droplet size, pesticide product, tank mixing and the use of adjuvants."

Response: Detection of pesticides in resident's urine does not necessarily indicate that a registered label violation has occurred. Numerous studies of applicators and their families have routinely found detectable concentrations of pesticides in their urine even when applicators carefully follow label instructions. OHA relies on ODA and ODF to ensure that pesticides in Oregon are applied according to the labels.

Comment 51: One commenter recommended that OHA:
"1. Obtain spray records for 2009-2013.
2. Ascertain why there have been increases in
   a. Number of spray applications
   b. Pounds of pesticide applied
   c. Increase in the pesticide products sprayed
   d. Increase in the pounds applied per acre
3. Fill in the data gaps to evaluate how repeated applications, tank mixes, adjuvants and aerial spray may increase risk to public health.
4. Use different ways to evaluate the spray data for environmental toxicity and impacts to public health. RfDs and BEs are narrow ways to view the data; we recommend a systems approach.
5. Evaluate individual practices of the timber operators and make recommendations to develop policies that ensure the safest practices that will protect nearby communities from aerial drift and exposure to 2,4-D and Atrazine."

Response:
1. See responses to comments 13 and 45
2. Items under recommendation 2 are beyond the scope of the current report
3. These questions are beyond the scope of the current EI and require research budgets not available to the EI team.
4. Environmental toxicity is beyond the scope of OHA's expertise and involvement in the EI. Developing a new method to evaluate human toxicity of pesticides beyond RfDs and BEs is an extremely time and resource intensive process that is beyond the capability of the EI team.
5. Continued work on the EI may help to reach some of the goals in this recommendation. Recommendations in the report itself are designed to protect nearby communities and obtain additional information needed to assess the health risk of area pesticide application practices.

Comment 52: Several commenters stated that they have used various pesticides including 2,4-D and atrazine for many years and have never seen any ill health effects as a result in themselves, their families, or their friends as a result.

Response: Individual experiences or anecdotal information can be helpful in identifying areas for further study. However, without systematic measurement, such information is not usually sufficient to draw conclusions about the burden of disease in a community.

Comment 53: A few comments stated that the report is fatally biased and flawed and should be rewritten or not published

Response: OHA acknowledges that no report can please all readers. All comments are valued and recorded.

Comment 54: A few comments asked for a spray drift study in the Highway 36 Corridor.

Response: EPA is developing plans for future air monitoring to determine concentrations of pesticides in air over a few weeks at a time that span one or more aerial applications. This is not a drift study per se, but will be useful information to help answer questions about human exposure.

Comment 55: Several comments accused state and federal regulators and state and local elected officials of allowing pro-pesticide lobby and trade associations to unduly influence their decisions in regulating how pesticides are used in Oregon and in thwarting efforts to complete originally planned sampling in the spring of 2012.

Response: This comment has been noted.

Comment 56: Some comments accused individual staff on the EI team of demonstrating bias in interactions with community members and in the report.

Response: This comment has been noted.

Comment 57: Some comments stated that atrazine should be banned in the United States as it is in the European Union.

Response: Banning any particular pesticide is beyond the scope of this EI and national policy is beyond the scope of OHA's authority.

Comment 58: "The Oregon Forest Practices Act is a 40 year old policy and is ineffective in protecting rural communities from the impacts of forestry operations for their homes, schools, gardens, drinking water and other activities; the OFPA fails to monitor pesticide applications and the environmental fate of these chemicals, fails to ensure that any aerial practice does not exceed the product label recommended maximum height of ten feet which is used by the EPA to assess drift risk off-site drift; does not address weather, slope, wind direction and swath adjustment for moving wind and fog; and does not address deposition, run-off and chemical-laden sediment in streams."

Response: The Forest Practices Act is the result of state legislation, and as such, it would require legislative action to change it. OHA encourages citizens to work with their elected officials to address concerns about this or any other state law.

Comment 59: "Legal Responsibilities and Rights – Though it may be outside of the scope of your study, I feel that it would strengthen the assessment of a section was added that clearly outlined both the specific responsibilities that state agencies and leaders have for monitoring, analyzing, and regulating use of chemicals in Oregon forests, and the rights of Oregonian related to use of chemicals in Oregon forests. I would assume that this would include such things as my right, as a forest owner, to use chemicals, and the right of my neighbor not to be poisoned by the chemicals that I use. One role of government is to sort out how best to balance these two rights. Your assessment would be more helpful if it both highlighted these types of tensions and explained how we currently resolve the tensions between these two rights."

Response: A summary of legal authorities regulating pesticide use in forest practice and the agencies responsible for administering those laws is outside the scope of this report but has been posted to OHA's website at:
http://public.health.oregon.gov/HealthyEnvironments/TrackingAssessment/EnvironmentalHealthAssessment/Hwy36/Documents/Oregon%20Regulations%20on%20Pesticide%20Applications_final.pdf

Comment 60: "~~Beyond Toxics~~[Redacted] suggests that the final report reference the Washington Forest Practices Act as a viable model for policy changes that would:
1. Align forest practices in neighboring states;
2. Create consistency for timber operators who have operations in both Washington and Oregon, and have a history of compliance with the Washington Forest Practices Act;
3. Promote monitoring and metrics, two aspects of developing good science and reliable data;
4. Provide a blueprint to update the 40-year-old Oregon Forest Practices Act to reflect new information about health and environmental harms associated with pesticide use.
5. Provide the suggested notification of upcoming pesticide sprays that are necessary for rural communities who seek to protect their families, their home grown food and their property."

Response: See response to comment 59. For a comparison of aerial pesticide application practices in the Pacific Northwest see the analysis written by EPA's Region 10 office here:
http://public.health.oregon.gov/HealthyEnvironments/TrackingAssessment/EnvironmentalHealthAssessment/Hwy36/Documents/Oregon%20Regulations%20on%20Pesticide%20Applications_final.pdf

Comment 61: "The basis of the decision for Conclusions 19 and 20 (now Conclusions 21 and 22) are misleading. We observe that a great deal of frustration and friction arises from the lack of credible and meaningful response from state agencies and the Board of Forestry. The community needs a response from the government that respects citizens' rights not to be poisoned and eliminates pesticide exposure from chemical trespass."

Response: OHA received and responded to several similar comments (see below) and revised Conclusion 19 (now Conclusion 21) to broaden the language to include frustrations other than those existing among and between community members.

Comment 62: "While understanding that divisiveness is not healthy for any local community, and many expressions of local distress have been disrespectful and counterproductive, we'd like the PARC team to recognize that their actions also serve a role in the system, and being "neutral scientists" does not exempt the group from impacting the conflict and potentially further polarizing the community. In particular, we would like PARC to:

- respond with more concern to those most vulnerable and expressing distress – this includes validating subjective experience rather than invalidating this experience as untrue until proven by research to be otherwise
- holding an appropriate empathetic presence to those whose lives have been seriously impacted by events described to the PARC team
- allow residents to speak directly to the PARC team in any future meetings rather than have the community "speak to one another," an action which appears self-protective rather than productive. It is also obfuscating to communicate details of the investigation and government agency intricacies beyond the interest and understanding of most participants, rather than distill this information in an appropriate manner in order to open the discussion in a more constructive manner.
- avoid advice that can sound patronizing, and assessment that local conflict can be reduced to "property rights issues" or "different values." All people value health – this is not up for question. When encountering hostility, anger or lack of trust, it may be useful to look into the ways in which they are also a response to the way in which the public agencies have failed to protect public health in the past despite the good intentions of this current PARC team. While not conducive mindsets to positive change, we feel it is inappropriate to blame local residents for poor behavior on top of their original and long standing complaint and to reduce this very serious environmental issues to lifestyle preferences."

Response: Thank you for your comments and suggestions; we will consider them in our future efforts with the investigation. The community concerns section of the report (pp. 40) is where we describe people's subjective experiences more fully, and hopefully, more meaningfully.

Comment 63: "In regard to the section of your preliminary report that addressed internal community relations and, in your opinion, the value of a mediator, we hereby agree but with one key difference: The mediation process would be valuable but the participants in the mediation should be between industry reps and those community members that feel have been harmed by their practices. I – the lead petitioner to the EPA – have never once had any problem with a local farmer or any other community member."

Response: OHA recognizes that formal mediation is one approach among many that could help reduce community stress and improve well-being. If all parties are receptive to the idea stated in the comment, then community leaders, formal leaders (i.e. elected officials), or others in a leadership role can take an active role in initiating that process.

Identifying leadership to spearhead the effort is a critical first step. In the event the community would like to look into professional mediators, here are a few resources to consider. OHA does not have experience with any of these resources and cannot recommend one over the other:

- *The Center for Dialogue & Resolution (formerly Community Mediation Services): www.communitymediationservices.com Phone: (541) 344-5366*
- *The Oregon Mediation Association: www.omediate.org Phone: 503-872-9775*
- *Linn-Benton Mediation Services: 541-928-5323*
- *Your Community Mediators of Yamhill County: http://www.ycmediators.org/ Phone: 503-435-2835*

- *Six Rivers Community Mediation (has an agriculture disputes program): http://www.6rivers.org/community-mediation.html Phone: 541-386-1283*
- *Oregon Solutions: www.oregonsolutions.org/about/contact-us phone: 503-725-9092*

Comment 64: Several commenters felt that the agencies involved in the investigation should increase their knowledge of environmental justice (EJ) issues and establish EJ-related goals for the remainder of the investigation. One commenter felt that the community was denied meaningful public input and instead was blamed for the conflicts and dysfunction. From their viewpoint, this constituted "a violation of EJ principles". This commenter also recommended that the federal agencies on the Investigation Team set a goal of complying with the 1994 Presidential Executive Order 12898 on Environmental Justice.

Response: EPA defines environmental justice (EJ) as "the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies."

OHA is dedicated to the principles of environmental justice. OHA has worked throughout the EI process to incorporate input from Highway 36 Corridor community members who have provided a broad range of viewpoints. OHA's efforts to solicit and incorporate meaningful input from the community have included:

- *Engaging in multiple phone conversations, in-person conversations, emails and listserv updates to and from community members;*
- *Coordinating and hosting three large community meetings that included significant portions dedicated to listening to the community, with input from the community on how that was accomplished;*
- *Coordinating an open house with all involved agencies, as an opportunity for community members to ask questions of and give feedback to the investigation team;*
- *Coordinating a data-sharing open house with community members to share community-collected environmental data and give permission for OHA to include the community-collected urine samples for consideration to be included in the report;*
- *Participating in a community-led conference call with a professor of biochemistry & molecular biology about endocrine disruptors (at the request of community members);*
- *Incorporating and analyzing community-collected air, water and urine data into the report;*
- *Sending out mass mailings, distributing surveys and seeking input on community engagement approaches;*
- *Responding to requests for information, reading literature submitted by community members;*
- *Securing and documenting the chain of custody for the community collected urine samples in order for them to be included in the report;*
- *Soliciting, describing and documenting community concerns; and*
- *Continuing to be a source of information, updates, outreach, and resources*

It is OHA's intention to engage with community members in a meaningful way and support partner agencies to do the same in any future activities related to this investigation.

Comment 65: "The draft report contains two conclusions regarding community conflict over the issue of pesticide use in the study area. In my opinion, this is what is popularly called a "red herring" designed to distract attention from the fact that stress in the study area has resulted from the abject failure of Oregon's state agencies to responsibly address the concerns of study area residents for up to seven years before this investigation began. While I believe that the OHA staff who are participating in this investigation are approaching their work professionally and responsibly, there is no doubt that the residents of the study area have been ignored, insulted, and treated badly for many years by the Oregon Departments of Forestry and Agriculture, as well as the multi-agency Pesticide Analytical and Response Center (PARC)… I saw first-hand how individuals who complained about pesticides to state agencies were ignored, vilified, and demonized by staff from ODA and ODF in particular. It is the nature of regulatory agencies in this country to develop strong ties with the regulated community, and in this case, those ties have interfered with the ability of ODA and ODF in particular to appropriately respond to community concerns regarding potential ill effects from pesticides."

Response: We understand that concerns have been ongoing for many years. Identifying safety concerns is one of public health's roles when working with communities, and OHA is concerned that underlying animosities could result in property damage, personal injuries or worse. We have identified personal safety, mistrust of government and inadequate protection of public health as explicit community concerns that were reported directly to us. Conclusions 19 & 20 (now 21 and 22) were not intended to distract attention from public agencies' responsibilities, but rather to highlight a significant finding of concern.

Comment 66: "The following statement is taken from page iii of the draft report:
"The Highway 36 Corridor EI is a multi-agency effort to respond to several community members' requests to investigate possible exposures to pesticides and herbicides used in applications in the Highway 36 corridor." In fact, the impetus for this investigation was not the requests of community members to investigate possible exposure to pesticides and herbicides; it was the testimony of a national expert in pesticide exposure that residents' urine tested positive for 2,4-D and atrazine, at levels higher than found in the general population. Requests by residents for investigation were routinely ignored by state agencies for years, and it was only when exposure was already documented by urine testing that the state took notice. With all due respect, I suggest that starting out this report with such an obviously self-serving statement that stretches the truth will do little to add to the report's credibility. It would be refreshing, indeed, if the authors would acknowledge the truth—that it was only after pesticide exposure had been documented by urine tests from an acknowledged national expert that state officials took any action at all."

Response: This comment has been noted. OHA added language in the report's forward that more explicitly describes how the EI was initiated.

Comment 67: Some comments expressed concern that the recommendation to improve notification of neighbors about impending forestry pesticide applications places the burden on citizens to protect their health and their children's health (e.g. by leaving their homes for a time) rather than controlling the source of the pesticides.

Comments expressed that state and federal agencies should not allow aerial pesticide applications at all, claiming that it is a human right to not be exposed to hazardous chemicals that have trespassed onto their own private property or public property where they may be exposed.

Response: While OHA recognizes that many people are dissatisfied with pesticide application practices and regulation of pesticide use in Oregon, the Oregon Forest Practices Act (FPA) regulates pesticide use in Oregon's state and private forests. ODF is the state agency responsible for administering the FPA. ODF responded to this comment, "The FPA directs the Oregon Board of Forestry to adopt administrative rules to encourage economically efficient forest practices consistent with natural resource protection. Under the authority of the FPA, the Board has adopted the Chemical and Other Petroleum Product Rules regulating pesticide use on private and non-federal public forestland. The Oregon Department of Forestry administers the FPA and associated administrative rules, but neither the Board nor the Department has the authority to ban pesticide use to protect human health, as long as ~~the uses are allowed by federal and other state laws~~federal and other state laws allow the uses. If there are monitoring or research findings indicating that current forest practices for pesticide applications result in quantities in soil, air or waters of the state that are injurious to water quality or the overall maintenance of terrestrial wildlife or aquatic life, the board may consider the need for forest practice rule changes. The Board intends that that the FPA and administrative rules work together with federal regulations (U.S. EPA's product registration and labeling requirements) and other state regulations (Oregon Department of Agriculture's Pesticide Control Law) in an integrated pesticide regulatory framework that protects human life, health and property, and the environment. Citizens who believe changes are needed in the FPA may contact their state elected officials to talk about their concerns."

For more information about how pesticide use is regulated in Oregon, see the summary on OHA's website here:
http://public.health.oregon.gov/HealthyEnvironments/TrackingAssessment/EnvironmentalHealthAssessment/Hwy36/Documents/Oregon%20Regulations%20on%20Pesticide%20Applications_final.pdf

Comment 68: "My over-all observation is that if one detects a few parts per trillion in urine, and that this detection differs slightly or not at all from the general population, *there is no possibility of identifying the source, and that the exposures are trivial and low priorities for investigations* (italicized emphasis part of original comment as received). This should have been a guiding principle in this investigation as soon as the first evidence of urine samples had been evaluated."

Response: This comment has been noted. Urine concentrations in the investigation area have been measured in the parts per billion range, not parts per trillion. The EI was initiated not only in response to measured urine concentrations but also in in response to community requests.

Comment 69: "Holistic vs. Reductionistic [sic] Assessments - Though I understand that the nature of the division of responsibilities between state agencies presents challenges in doing this, I feel strongly that future research into the impacts of chemical use in Oregon forests should use a holistic and integrated approach by investigating the impacts on all of the major living communities in the study are – human and more than human. Continuing to do research in isolated silos compromises our collective success in fulfilling our responsibilities to accurately understand the impacts of chemical use across the landscape."

Response: This comment has been noted. While OHA's focus in the EI and on this report is human health, OHA has collaborated with agency partners such as DEQ, ODA, ODF, EPA, and ATSDR throughout the process. OHA is keenly aware that the natural environment and human health are linked, and OHA collaborates with other agencies to ensure that this connection is understood.

Comment 70: One commenter pointed out that the investigation has not analyzed the urine of individuals living within a few hundred feet of aerial sprays, and that participants in the Exposure Investigation lived miles from known applications. The commenter stated that no samples were collected on the same day of exposure, and that those participating in the community-collected urine sampling lived an average of 1.5 miles away from spraying activity and that OHA has not and cannot comment on the level of harm to those living within a few hundred feet of aerial sprays.

Response: All scientific studies are limited in their conclusions by the data collected. One of the areas in which this EI is limited is that data only exists for the individuals that participated in the investigation. There may have been residents living closer to pesticide applications than those participating in the EI, but without data, OHA is unable to support conclusions on how those individuals may have been affected by pesticide applications.

Appendix B: Application Records

OHA requested 2009-2011 application records from ODA and ODF in October 2011 and received most of the application records in June 2012. This section describes OHA's analysis of 2011 application records.

2011 Application Records: Descriptive Statistics

There were 161 reported pesticide applications in the Highway 36 investigation area during 2011. Forty-one (25%) of these 161 reported applications were only reported to ODA, and 120(75%) applications were reported to ODF. Based on OHA's interpretation of the data, 10 (6%) of the 161 applications were for agricultural purposes (e.g., applications on Christmas tree farms and pastureland), 133 (82%) were for forestry operations, and 18 (11%) were roadside applications. Table B1 shows a breakdown of the 2011 application data by these three major "sectors".

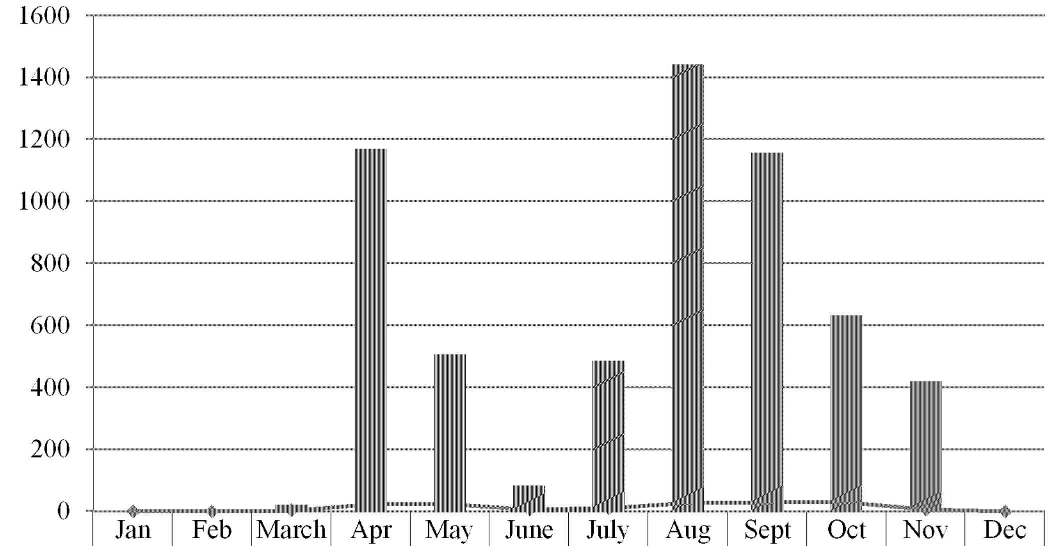
Table B 1: 2011 application data by sector

	Agricultural	Forestry	Roadside	Total
Applications	10 (6%)	133 (82%)	18 (11%)	161 (100%)
Acres Treated	90 (2%)	5,750 (97%)	83 (1%)	5,923 (100%)
Amount pesticides applied (gallons)	128.6 (6%)	2043.5 (92%)	53.5 (2%)	2225.6 (100%)
Amount pesticides applied (pounds)	60.0 (4%)	1345.9 (96%)	0.0 (0%)	1405.9 (100%)

% = percent
Percentages do not add up to 100% because of rounding

There were no applications in January and February, and three applications on 22 acres of land at the end of March (Figure B1). There were 23 applications on 1,171 acres in April, and 24 applications on 508 acres in May. There were few applications in June, 11 applications on 486 acres in July, and 27 applications on 1,442 acres in August. There ~~were 29~~were 29 applications on 1,157 acres in September, 30 applications in October on 632 acres, and seven applications in November on 414 acres. There were no applications in December 2011. See Figure B1 below.

Figure B 1: Applications and acres treated in 2011 by month.*



	Jan	Feb	March	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Acres Treated	0	0	22	1170.5	508	84.3	485.5	1442	1157.3	632.4	421	0
Applications	0	0	3	23	24	7	11	27	29	30	7	0

* Note: Two applications in March, one application in June and one application in July were missing data on acres treated.

Aerial applications accounted for 23% of 2011 applications, and roughly 37% of acres in the investigation area were treated with this method (Table B2). Approximately 22% of applications were hack and squirt treatments (34% of acres), 11% of applications were roadside applications, and approximately 27% of applications were ground-based treatments (18% of acres).

Table B 2: Application methods for 2011 pesticide applications in investigation area.*

Application Method	Number of Applications	Acres Treated
Aerial	37 (23%)	2198.5 (37%)
Ground	44 (27%)	1045.2 (18%)
Roadside	18 (11%)	82.8 (1%)
Hack and Squirt	35 (22%)	2022.0 (34%)
Unknown	27 (17%)	574.5 (10%)
Total	161 (100%)	5923.0 (100%)

*Note: We inferred application method for six aerial applications, three ground applications and two roadside applications. % = Percent. Percentages do not add up to 100% because of rounding.

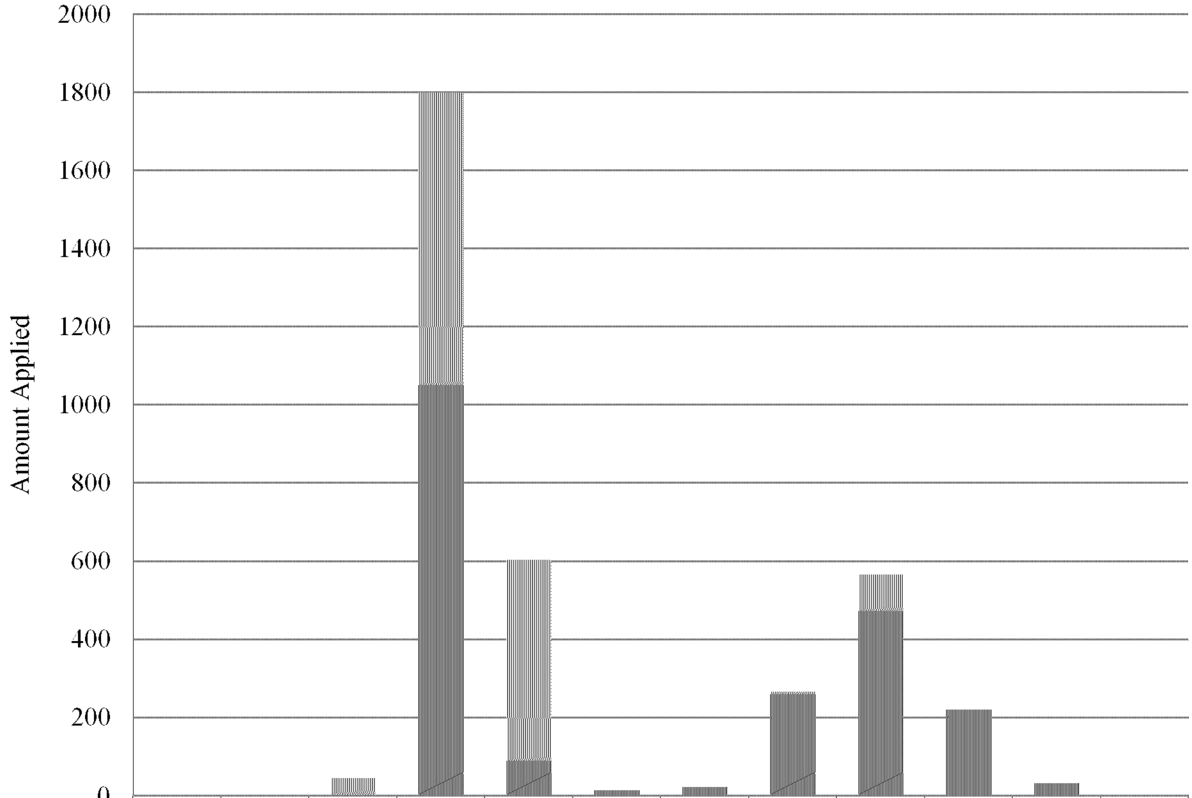
During 2011, an estimated 2,168 gallons of liquid pesticides and 1,406 pounds of dry pesticides[20] were applied in the investigation area (Figure B2). There were ten pesticides (not including adjuvants)

[20] These are estimates of pesticides in liquid and dry form before they were mixed with water, surfactants and other additives.

applied in the same area in 2011: 2,4-D, aminopyralid, atrazine, clopyralid, glyphosate, hexazinone, imazapyr, metsulfuron methyl, sulfometuron methyl, and triclopyr. Pesticide amounts were reported as a mixture of pounds and gallons. It is possible to convert gallons to pounds, but OHA did not have the time resources to make those conversions for this report. Without making this conversion, it is not possible to rank pesticides by overall amount applied. The pesticides used were: hexazinone (1,304 lbs/50 gallons), glyphosate (710 gallons), atrazine (702 gallons), 2,4-D (345 gallons) and imazapyr (252 gallons). 2,4-D, atrazine, clopyralid, and hexazinone were used exclusively during during the early part of the year (April and May), while imazapyr, metsulfuron methyl, and sulfometuron methyl were used predominantly in late summer and fall applications (Table B3).

In the investigation area, the township ranges with the most pesticide applications and largest number of acres treated were 16S 06W and 16S 07W (Figure B3). The township ranges with fewest applications (and fewer acres treated) were 16S 08W and 17S 07W.

Figure B 2: Amounts of pesticide products applied in 2011 by month.*



	Jan	Feb	March	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Pounds	0.0	0.0	44.0	747.8	514.5	0.0	0.0	5.8	93.9	0.0	0.0	0.0
Gallons	0.0	0.0	1.1	1051.5	90.0	14.1	23.4	261.0	473.4	220.5	33.0	0.0

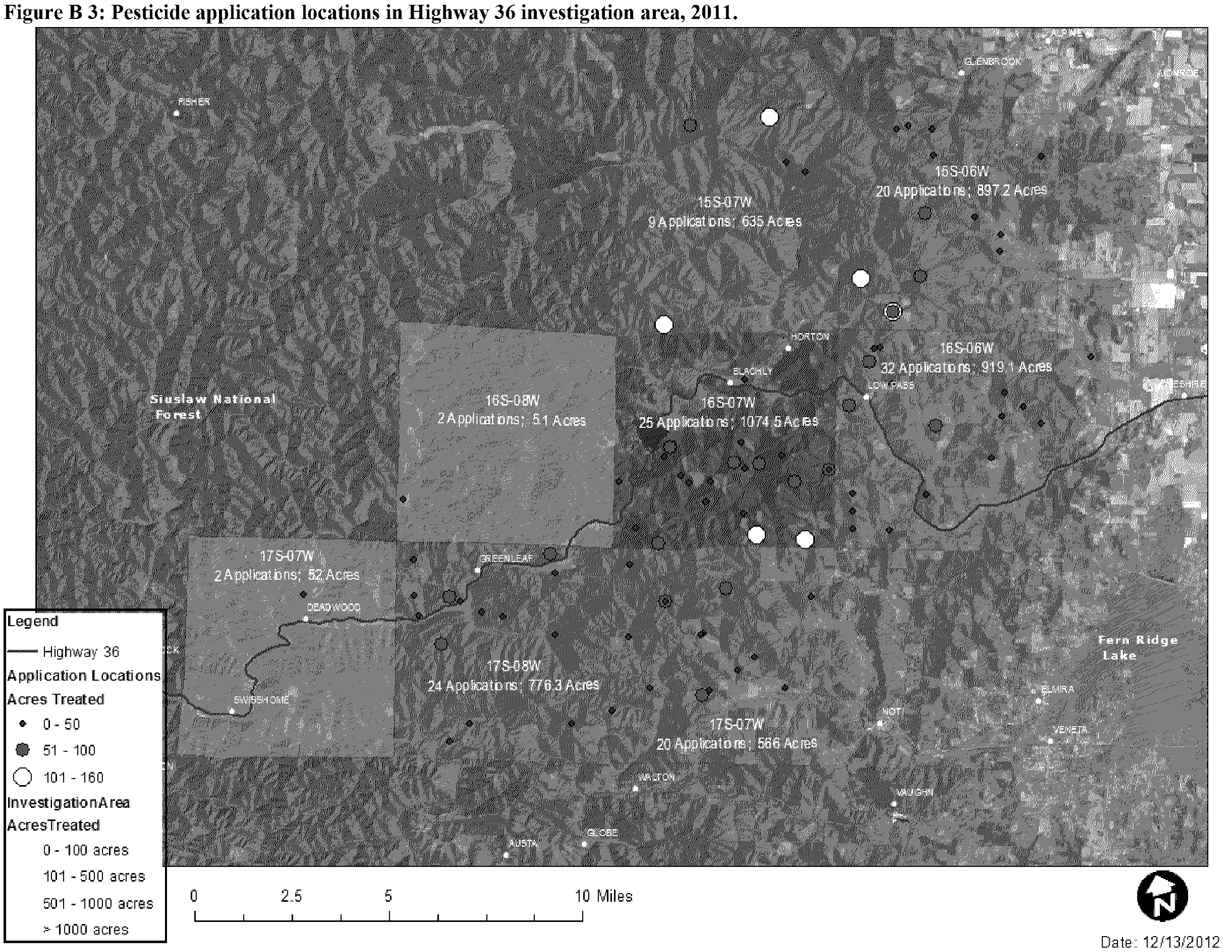
* Note: The amount applied does not include adjuvants or carriers (e.g., water, surfactants, and dyes). Two applications (one in March, one in August) were missing data indicating the amount applied.

Table B 3: Amount of pesticides applied in 2011 by month (darker shading indicates larger amounts).

Active Ingredient	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Total
2,4-D (gal)		325.4	20.0							345.4
Aminopyralid (gal)		1.5			0.6	2.7	0.5			5.3
Aminopyralid, Triclopyr (gal)			5.1	1.2	1.5					7.8
Atrazine (gal)		672.6	29.0							701.6
Clopyralid (gal)		10.8	2.1							12.9
Glyphosate (gal)	1.0	2.5	22.0	12.8	16.5	202.4	330.9	167.5	2.6	709.5
Hexazinone (gal)		38.6	11.2							49.8
Hexazinone (lbs)	44.0	745.8	514.2							1304.0
Imazapyr (gal)			0.3		3.8	48.6	140.4	44.9	30.4	251.5
Metsulfuron methyl (gal)						0.1	0.9	0.2		1.3
Metsulfuron methyl (lbs)						5.8	22.6			28.3
Sulfometuron Methyl (gal)	0.1					3.8	0.6	4.0		8.6
Sulfometuron Methyl (lbs)		2.0	0.4							2.3
Sulfometuron methyl, Metsulfuron methyl (gal)						3.3		3.8	0.2	3.3
Sulfometuron methyl, Metsulfuron methyl(lbs)							71.3			71.3
Triclopyr (gal)			0.8	1.3	21.8	24.6	8.6	0.8		57.5
Total (gal)	1.1	1051.5	90.5	15.3	45.2	285.5	482.0	221.2	33.2	2225.6
Total (lbs)	44.0	747.8	514.5	0.0	0.0	5.8	93.9	0.0	0.0	1405.9

*Notes: Excludes carriers and adjuvants. One application of glyphosate and sulfometuron methyl in March, and one application of glyphosate and triclopyr in August were missing data on the amount applied. Gal = gallons; lbs = pounds.

Figure B 3: Pesticide application locations in Highway 36 investigation area, 2011.



Data Processing and Analysis

The ODA and ODF application data were processed in Excel and SAS to obtain a single dataset of 2011 pesticide applications in the Highway 36 investigation area. The final merged dataset had data on 161 applications (Table B4). SAS was used to obtain basic descriptive statistics (e.g., number of applications per month, acres treated) for the pesticide application data.

Table B 4: Number of records and applications in 2011 dataset.

	ODA Records	ODF Records
Files	-	88
Total Observations (Rows)	165	324
Number applications	100	120
ODA applications not in ODF dataset	41	
Total applications	161	
ODF – Oregon Department of Forestry; ODA = Oregon Department of Agriculture		

ODF Records Data Entry

OHA staff abstracted all available ODF records for 2011. Data were abstracted into an Excel spreadsheet. Table B5 shows the fields abstracted from the records. One OHA staff member abstracted records from January – July 2011, and another OHA staff member abstracted records from August – December 2011.

Table B 5: Data fields abstracted from ODF records.

Data Field	Notes
Notification and Unit Number	-Indicates the corresponding ODF notification number
Application Date	-Date of application. Some records had more than one date on the record. If the record indicated the amount of chemicals applied on each date, we entered each date as a unique application. If the record provided the total amount of chemicals applied over several dates, we treated the record as a single application, and entered multiple dates/times in the appropriate cells.
Project Name	Name of treated unit
Landowner, Operator, Contractor	The Landowner and Contractor fields were abstracted from records; the operator field was populated based on information on ODF's SharePoint site.
Township, Range and Section	Township-Range-Section location of treated unit. If the area spanned multiple sections, we entered all sections separated by commas (e.g., 10, 12, 14).
Longitude, Latitude	Many records did not have latitude/longitude indicated. For these records, we estimated coordinates using the following process: 1) If the record (or corresponding notification) included a map of the unit, we visually identified the unit using ArcGIS, and used the rough center point of the unit for longitude/latitude coordinates. 2) If no map was available, we used the coordinates of the center point of

Data Field	Notes
	T/R-Section in which the unit was located. Note: Used GCS_NA_1983 coordinate system
Other location	Not standard across records; may drop this field. Some records indicated elevation (entered as E:XXXX). A few applications occurred in Benton County, but within our investigation area.
Acres	Most records indicated the number of acres treated, though a few records of roadside treatments indicated miles instead of acres.
Chemical Supplier	Entered company indicated on record; left blank if not indicated.
Product Name and Registration Number	Chemical name and EPA registration number. In some cases, the product name and registration number did not match up. In these cases, we crosschecked the information with ODA application records, or used our professional judgment to enter the correct product name and corresponding registration number. In addition to registered products, we entered data on adjuvants (e.g., surfactants, dyes).
Active Ingredient	Identified from EPA product labels
Product Application Rate	In most cases, we entered the product application rate as indicated on the record. If the rate was not provided on the ODF record, but provided in a corresponding ODA record, we entered the ODA application rate. In some cases, we back calculated the rate by dividing the total amount applied by acres.
Product Total	Total product applied during the application. If the total was not provided on the record, we calculated the total amount by multiplying the application rate by number of acres.
Carrier	Product carrier used during application
Carrier Rate	Product carrier rate. In some cases, we back calculated the rate by dividing the total amount applied by acres, or estimated the rate based on the percentages provided on the record.
Carrier Total	If the total was not provided on the record, we calculated the total amount by multiplying the application rate by number of acres, or estimated the total based on the percentages provided on the record.
Start Time and End Time	The start and end time indicated on the application record.
Total Rate and Total Applied	The total amount of product(s) and carrier applied during an application. If not indicated on the record, we calculated this field based on product and carrier rates/totals.
Application Type	This information was not indicated on some records. In some cases, we inferred application type based on other information on the record (e.g., equipment used, meteorological data).
Meteorological Information	We entered the time of measurement, temperature, humidity, wind speed, and wind direction for up to 4 meteorological readings. A few records (with multiple application dates) had more than 4 readings; for these, we entered the first four readings.
Planting Date	Date/Year unit was planted; rarely indicated on record, may drop this field.
Target Species	Species targeted during application.
Equipment Used	Equipment used for application; sometimes method was indicated (e.g., hack and squirt)

Data Field	Notes
ODF – Oregon Department of Forestry; T = Township; R = Range; EPA = Environmental Protection Agency; ODA = Oregon Department of Agriculture	

Data Quality Check
To ensure the data were abstracted correctly, all data entries were checked against the actual application record by OHA staff. In addition, ODF conducted a 10% check of abstracted records.

ODA Records Acquisition and Data Quality Control
The following pages are an ODA document describing the records acquisition and data quality control process that ODA used in support of this EI.

Appendix C: Comparison Values Used to Evaluate Biological and Environmental Samples

Many State and Federal agencies develop comparison concentrations for chemicals in various media (urine, water, food, soil, etc.). The purpose of this Appendix is to explain how OHA selected and derived the comparison values (CVs) used in this report.

<u>Urine</u>

Urine is a unique medium for evaluating pesticide exposures because no clear associations have been drawn between specific urine concentrations and health outcomes in humans. OHA compared the urine results from this EI to those measured in the general population through the National Health and Nutrition Examination Survey (NHANES) and reported in the Fourth National Report on Human Exposure to Environmental Chemicals [20]~~[16]~~. For 2,4-D, OHA compared the EI results to the NHANES 75^{th} and 95^{th} percentiles. OHA also compared the 2,4-D results to the biomonitoring equivalent (BE) for 2,4-D. A BE represents the estimated concentration of 2,4-D that would be present in the urine of a person who was chronically exposed to 2,4-D at a dose equal to EPA's reference dose (RfD) for 2,4-D. The BE for chronic exposures (lasting more than 7 years) to 2,4-D is 200 µg/L; for acute exposures (lasting one day), the BE is 400 µg/L for women of reproductive age and 1,000 µg/L for the rest of the population [23], [24]~~[19 – 20]~~. There are no national reference values for atrazine in urine. Therefore, OHA searched peer-reviewed literature for smaller studies where the same atrazine metabolites were measured in human urine (see Table 12).

<u>Water and Soil</u>

OHA used ATSDR's hierarchy for choosing CVs for water and soil (Figure C1). If a hierarchy 1, 2 or 3 CV was not available, EHAP chose the lowest of EPA's Regional Screening Levels (RSL), U.S. Geological Survey's Health-based Screening Levels (HBSL), or EPA's Human Health Benchmark for Pesticides (HHBP). Tables C1 and C2 show the CVs used for water and soil respectively.

Figure C 1: ATSDR's hierarchy for selecting comparison values in water, soil, and air [6].

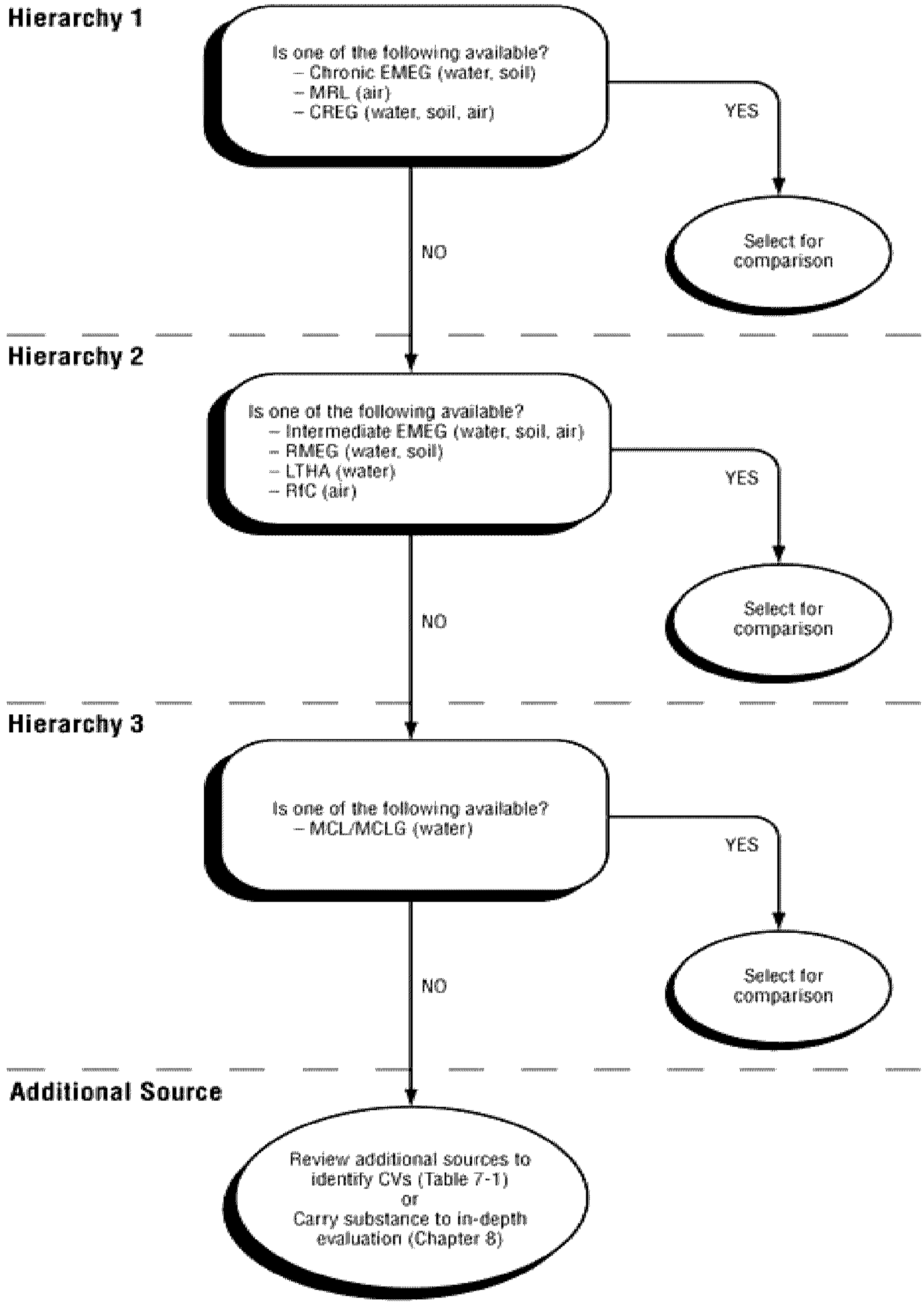


Table C 1: Analytes, detections, and comparison values for water samples.

Analyte	Detections (N = 37)**	Maximum Detected (ppm)	Comparison Value (ppm)	CV Source
2 (2,4,5-Trichlorophenoxy) propionic acid (2,4,5-TP/Silvex)	0	<0.00011	0.05	LTHA
2,4,5-Trichlorophenoxyacetic Acid 2,4,5 (2,4,5-T)	0	<0.00033	0.07	LTHA
2,4-Dichlorophenoxyacetic Acid (2,4-D)	0	<0.00011	0.1	RMEG
3,5-Dichlorobenzoic acid	0	<0.00033	NA	-
4-(2,4-dichlorophenoxy) butyric acid (2,4-DB)	0	<0.00066	0.08	RMEG
4-chloro-2-methylphenoxyacetic Acid (MCPA)	0	<0.022	0.005	RMEG
Acetamiprid	0	<0.0000041	0.5	HHBP
Acetochlor	0	<0.00001	0.2	RMEG
Acifluorfen	0	<0.00022	0.09	HBSL
Alachlor	0	<0.000031	0.1	RMEG
Aldrin	0	<0.000026	0.0000021	CREG
alpha-Chlordane (cis-Chlordane)	0	<0.000026	0.0001	CREG
alpha-Hexachlorocyclohexane (alpha-BHC)	0	<0.000026	0.000006	CREG
Ametryn	0	<0.0000041	0.06	LTHA
Aminocarb	0	<0.0000041	NA	-
Atrazine	0	<0.000051	0.03	Intermediate EMEG
Baygon	0	<0.0000041	0.003	LTHA
beta-Hexachlorocyclohexane (beta-BHC)	0	<0.000026	0.000019	CREG
Bifenthrin	0	<0.000082	0.091	HHBP
Bromacil	0	<0.000026	0.07	LTHA
Butachlor	0	<0.000026	NA	-
Butylate	0	<0.000026	0.4	LTHA
Carbaryl	0	<0.0000051	1	RMEG
Carbofuran	0	<0.0000041	0.05	RMEG
Chlorneb	0	<0.000026	0.09	HHBP
Chlorobenzilate	0	<0.000026	0.2	RMEG
Chlorothalonil	0	<0.000026	0.15	RMEG
Chlorpropham	0	<0.000026	2	RMEG
Cyanazine	0	<0.000026	0.001	LTHA
Cycloate	0	<0.000026	0.035	HHBP
Dacthal (DCPA - Dimethyl tetrachloroterephthalate)	0	<0.000026	0.07	LTHA
DCPA (Dimethyl tetrachloroterephthalate) acid metabolites	0	<0.00066	0.07	LTHA* (Parent: DCPA)
delta-Hexachlorocyclohexane (delta-BHC)	0	<0.000026	0.000006	CREG* (Parent: alpha-BHC)

Analyte	Detections (N = 37)**	Maximum Detected (ppm)	Comparison Value (ppm)	CV Source
Desethyl Atrazine	0	<0.0000041	0.03	Intermediate EMEG* (Parent: Atrazine)
Desisopropyl Atrazine	0	<0.0000041	0.03	Intermediate EMEG* (Parent: Atrazine)
Diazinon	0	<0.000026	0.007	Chronic EMEG
Dicamba	0	<0.00033	0.3	RMEG
Dichlorodiphenyldichloroethane (4,4'-DDD)	0	<0.000026	0.00015	CREG
Dichlorodiphenyldichloroethylene (4,4'-DDE)	0	<0.000026	0.0001	CREG
Dichlorodiphenyltrichloroethane (4,4'-DDT)	0	<0.000026	0.0001	CREG
Dichloroprop	0	<0.00033	0.3	HBSL
Dichlorvos	0	<0.000026	0.00012	CREG
Dieldrin	0	<0.000026	0.0000022	CREG
Dimethoate	0	<0.000026	0.002	RMEG
Dinoseb	0	<0.00033	0.007	LTHA
Diuron	0	<0.0000041	0.02	RMEG
Chlorpyrifos	0	<0.000026	0.01	Chronic EMEG
Endosulfan I	0	<0.000026	0.02	Chronic EMEG
Endosulfan II	0	<0.000026	0.02	Chronic EMEG* (Parent: Endosulfan I)
Endosulfan sulfate	0	<0.000026	0.02	Chronic EMEG* (Parent: Endosulfan I)
Endrin	0	<0.000026	0.003	Chronic EMEG
Endrin aldehyde	0	<0.000026	0.003	Chronic EMEG* (Parent: Endrin)
Ethoprophos	0	<0.000026	0.001	HBSL
Etridiazole (Terrazole)	0	<0.000026	0.112	HHBP
Fenamiphos	0	<0.000031	0.0007	LTHA
Fenarimol	0	<0.000026	0.042	HHBP
Fenvalerate/Esfenvalerate	0	<0.000512	0.25	RMEG
Fluometuron	0	<0.0000041	0.09	LTHA
Fluridone	1	0.000031	1.05	HHBP
gama-Hexachlorocyclohexane (Lindane)	0	<0.000026	0.0001	Intermediate EMEG
gamma-Chlordane (trans-Chlordane)	0	<0.000026	0.0001	CREG
Heptachlor	0	<0.000026	0.0000078	CREG
Heptachlor epoxide	0	<0.000026	0.0000038	CREG
Hexazinone	1	0.000183	0.4	HBSL
Imazapyr	0	<0.000041	17.5	HHBP
Imidacloprid	0	<0.00002	0.4	HHBP

Analyte	Detections (N = 37)**	Maximum Detected (ppm)	Comparison Value (ppm)	CV Source
Linuron (Lorox)	0	<0.0000041	0.005	HBSL
Malathion	0	<0.000026	0.2	Chronic EMEG
Methiocarb	0	<0.0000041	0.04	HBSL
Methomyl	0	<0.0000041	0.2	LTHA
Methoxychlor	0	<0.000026	0.04	LTHA
Methyl paraoxon	0	<0.000026	0.003	Chronic EMEG* (Parent: Methyl Parathion)
Methyl parathion (Parathion methyl)	0	<0.000026	0.003	Chronic EMEG
Azinphos-Methyl (Guthion)	0	<0.000041	0.03	Chronic EMEG
Methylchlorophenoxypropionic acid (MCPP)	0	<0.066	0.28	HHBP
Metolachlor	0	<0.000026	0.7	LTHA
Metribuzin	0	<0.000026	0.07	LTHA
Mevinphos	0	<0.000026	0.002	HHBP
Mexacarbate	0	<0.0000041	NA	-
Molinate	0	<0.000026	0.02	RMEG
N,N-Diethyl-3-methylbenzamide (DEET)	2	0.0000058	0.2	Minnesota Department of Health [21]
Napropamide	0	<0.000026	0.8	HBSL
Neburon	0	<0.0000051	NA	-
N-Octyl bicycloheptene dicarboximide (MGK 264)	0	<0.000051	0.427	HHBP
Norflurazon	0	<0.000026	0.01	HBSL
Oxamyl	0	<0.0000041	0.25	RMEG
Pebulate	0	<0.000026	0.05	HBSL
Penoxalin (Penoxsulam)	0	<0.000026	1.029	HHBP
Pentachlorophenol	0	<0.00011	0.000088	CREG
Permethrin	0	<0.000051	0.5	RMEG
Phosmet	0	<0.000026	0.004	HBSL
Picloram	0	<0.00066	0.5	MCL
Prometon	0	<0.0000041	0.15	RMEG
Prometryn	0	<0.0000041	0.04	RMEG
Pronamide	0	<0.000026	0.75	RMEG
Propachlor	0	<0.000026	0.13	RMEG
Propazine	0	<0.000026	0.01	LTHA
Propiconazole	0	<0.00002	0.07	HBSL
Pyraclostrobin	0	<0.0000041	0.24	HHBP
Pyriproxyfen	0	<0.000256	2.5	HHBP
S-ethyl dipropylcarbamothioate (EPTC)	0	<0.000026	0.25	RMEG
Siduron	0	<0.0000041	1	HBSL

Analyte	Detections (N = 37)**	Maximum Detected (ppm)	Comparison Value (ppm)	CV Source
Simazine	0	<0.000026	0.05	RMEG
Simetryn	0	<0.0000041	NA	-
Sulfometuron-Methyl	0	<0.0000041	1.9	HHBP
Tebuthiuron	0	<0.000026	0.5	LTHA
Terbacil	0	<0.000026	0.09	LTHA
Terbufos	0	<0.000041	0.0004	LTHA
Terbutryn	0	<0.0000041	0.01	RMEG
Terbutylazine	0	<0.0000041	0.002	HBSL
Tetrachlorvinphos (Stirophos)	0	<0.000026	0.3	HHBP
trans-Nonachlor	0	<0.000026	NA	-
Triadimefon	0	<0.000026	0.238	HHBP
Triclopyr	0	<0.00033	0.35	HHBP
Tricyclazole	0	<0.000026	NA	-
Trifluralin	0	<0.000026	0.0045	CREG
Vernolate	0	<0.000026	0.01	RMEG

N = Total number of samples; ppm = parts per million; CV = comparison value; < = Less than; NA = Not Available; - = Not Available; LTHA = Life-time Health Advisory; RMEG = Reference dose Media Evaluation Guide; HHBP = U.S. Environmental Protection Agency Human Health Benchmark for Pesticides [58]~~[54]~~; HBSL = U.S. Geological Survey Health-Based Screening Level [59]~~[55]~~; CREG = Cancer Risk Evaluation Guideline; EMEG = Environmental Media Evaluation Guide; MCL = Maximum Contaminant Level

* Comparison value for parent compound as surrogate for environmental degradates.
**37 samples include 36 drinking water samples and one surface water samples not used for drinking water.

Table C 2: Analytes, detections, and comparison values for soil samples.

Analyte	Detections (N = 29)	Maximum Detected (ppm)	Comparison Value (ppm)	CV Source
2,4-D	2	0.046	500	RMEG
Aminopyralid	0	<0.010	25,000	RMEG – provisional*
Atrazine	0	<0.010	150	Intermediate EMEG
Clopyralid	0	<0.010	25,000	RMEG – provisional*
Glyphosate	2	3.3	5,000	RMEG
Hexazinone	0	<0.010	2,000	RSL
Imazapyr	0	<0.010	125,000	RMEG – provisional*
Metsulfuron Methyl	0	<0.010	12,500	RMEG – provisional*
Picloram	0	<0.010	4,300	RSL
Sulfometuron Methyl	0	<0.010	13,750	RMEG – provisional*
Triclopyr	0	<0.010	2,500	RMEG – provisional*

N = Total number of samples; ppm = parts per million; CV = Comparison Value; < = less than; 2,4-D = 2,4-dichlorophenoxyacetic acid; RMEG = Reference dose Media Evaluation Guide; EMEG = Environmental Media Evaluation Guide; RSL = U.S. Environmental Protection Agency Regional Screening Level

*Provisional RMEG = Derived using the analyte's Reference Dose (RfD and the Agency for Toxic Substances and Disease Registry's drinking water RMEG equation for children. This was a fourth tier option because there were no other comparison values for these analytes.

Food

ATSDR does not have CVs for chemicals in food. Therefore, OHA used the hierarchy shown in Table C3 to select CVs for pesticides in food samples. Table C4 shows results for egg, milk and honey samples. Table C5 shows results for berry, leafy vegetable, and tomato samples.

Table C 3: Hierarchy used to select Comparison Values for food.

Hierarchy Level	Source of Comparison Value	Rationale
1	US EPA Pesticide Tolerance for foods [60]~~[56]~~	Chemical and medium specific
2	Tolerance or equivalent from World Health Organization [61]~~[57]~~ or Health Canada [62]~~[58]~~ *	Chemical and medium specific
3	European Union Default Maximum Residue Limit [63]~~[59]~~ (0.01 ppm)	Not chemical or medium specific

US EPA = US Environmental Protection Agency; ppm = parts per million
*If both the World Health Organization and Health Canada had a tolerance for a particular food, chose the lower of the two tolerances.

Table C 4: Analytes, detections, and comparison values for egg, milk, and honey samples.

	Eggs				Milk				Honey			
Analyte	Detections (N = 4)	Max Detected (ppm)	CV (ppm)	Source	Detections (N = 2)	Max Detected (ppm)	CV (ppm)	Source	Detections (N = 2)	Max Detected (ppm)	CV (ppm)	Source
2,4-D	0	<0.01	0.01	WHO	0	<0.01	0.05	EPA	0	<0.01	0.01	EU
Aminopyralid	0	<0.01	0.01	WHO	0	<0.01	0.03	EPA	0	NR	0.01	EU
Atrazine	0	<0.01	0.04	HC	0	<0.01	0.02	EPA	0	<0.01	0.01	EU
Clopyralid	0	<0.01	0.1	EPA	0	<0.01	0.2	EPA	0	<0.01	0.01	EU
Glyphosate	0	<0.01	0.05	EPA	0	<0.01	0.05	WHO	0	<0.01	0.01	EU
Hexazinone	0	<0.01	0.01	EU	0	<0.01	11	EPA	0	<0.01	0.01	EU
Imazapyr	0	<0.01	0.05	HC	0	<0.01	0.01	EPA	0	<0.01	0.01	EU
Metsulfuron Methyl	0	<0.01	0.01	EU	0	<0.01	0.05	EPA	0	<0.01	0.01	EU
Picloram	0	<0.01	0.05	EPA	0	<0.01	0.25	EPA	0	<0.01	0.01	EU
Sulfometuron-Methyl	0	<0.01	0.01	EU	0	<0.01	0.01	EU	0	<0.01	0.01	EU
Triclopyr	0	<0.01	0.05	EPA	0	<0.01	0.01	EPA	0	<0.01	0.01	EU

N = Total number of samples; Max = maximum; ppm = parts per million; CV = Comparison Value; < = less than; 2,4-D = 2,4-dichlorophenoxyacetic acid; NR = No Result; EPA= US Environmental Protection Agency; HC = Health Canada; EU = European Union; WHO = World Health Organization

Table C 5: Analytes, detections, and comparison values for berry and vegetation samples.

	Berries				Vegetation (Leafy Greens/Tomatoes)			
Analyte	Detections (N = 4)	Max Detected (ppm)	CV (ppm)	Source	Detections (N = 14)	Max Detected (ppm)	CV (ppm)	Source
2,4-D	0	<0.01	0.2	EPA	0	<0.01	0.05	EPA
Aminopyralid	0	<0.01	0.01	EU	0	<0.01	0.01	EU
Atrazine	0	<0.01	0.01	EU	0	<0.01	0.25	EPA
Clopyralid	0	<0.01	0.5	EPA	0	<0.025	5	EPA
Glyphosate	0	<0.01	0.2	EPA	0	<0.04	0.1	EPA
Hexazinone	0	<0.01	0.6*	EPA	0	<0.01	0.01	EU
Imazapyr	0	<0.01	0.01	EU	0	<0.01	0.01	EU
Metsulfuron Methyl	0	<0.01	0.01	EU	0	<0.01	0.01	EU
Picloram	0	<0.01	0.01	EU	0	<0.05	0.01	EU
Sulfometuron-Methyl	0	<0.01	0.01	EU	0	<0.01	0.01	EU
Triclopyr	0	<0.01	0.01	EU	0	<0.01	0.01	EU

N = Total number of samples; Max = maximum; ppm = parts per million; CV = Comparison Value; < = less than; 2,4-D = 2,4-dichlorophenoxyacetic acid; EPA= US Environmental Protection Agency; HC = Health Canada; EU = European Union; WHO = World Health Organization

*For blueberries

Appendix D: Fall 2011 Survey Questions on Home/Work Pesticide Use

Hi ________
Thank you for participating in the Highway 36 pesticide Exposure Investigation. We have a few questions for you to answer, that will help us learn more about any potential exposure to pesticides or herbicides you may have had in the last several days. Please reply to this e-mail, with your responses to the questions below. Please call me at 971-XXX-XXXX if you have any questions. Thank you.

We were at your house on ____________________.
....

1. Approximately how much time per day did you spend outdoors around your home, in the week (7 days) before providing your urine sample? Is that typical for you?

2. Do you work at home?

3. Do you use any pesticides or herbicides on your land or in your garden?

4. Do you have a job where you handle or are around pesticides or herbicides?
   If Yes:
   What do you use?

   What application method(s) do you use?

   How much do you use on a weekly basis?

5. Did you use pesticides or herbicides in the week (7 days) before providing your urine sample?
   If Yes:
   When did you apply them?

   What did you use?

   Where did you apply it?

6. Do you know of any herbicide applications that occurred near your home (within a mile or so) in the week before you provided a urine sample?
   If Yes:
   Where did that application occur?

   When did that application occur?

   Do you know what method was used to apply them (backpack, aerial spray)?

Thank you for your time!

Appendix E: Chain of Custody for Community-Collected Urine Samples

Description of urine collection and shipment process

1. Community organizers assigned each participant a unique alphanumerical Personal Identification Number (PIN).
2. A medical doctor in Eugene, OR provided prescriptions for urine collection.
3. Participants had urine samples collected at a PeaceHealth laboratory facility per PeaceHealth's Urine Collection Process and protocols PHL.ALL.271.114, PHL.ALL.69.05, PHL.OR.394.57 and PHL.ALL.69.7
    a. Each participant had their identification verified using two sources of identification confirming their full name and birthdate.
    b. Participants verified their unique PIN.
    c. Each sample was labeled with the unique PIN and a unique PeaceHealth Laboratory accession number (PHLAN). No personally identifiable information (e.g., name, birthdate) were included on the sample label.
4. A PeaceHealth courier transported the urine samples from the collection site to the PeaceHealth Send Out Department. Each sample was accompanied by a packing slip that included the specimen label (with PIN and PHLAN) and a copy of the original prescription.
5. The PeaceHealth Send Out Department packed and shipped the samples via United Parcel Service or Federal Express to the lab at Emory University in Atlanta, GA.
6. Packaged samples were received by Central Shipping and Receiving (CS&R) at Emory University, and were delivered to the laboratory by an Emory University courier.

Laboratory Analysis

The urine samples were analyzed for 2,4-D and atrazine using CDC's laboratory methods for these chemicals [38], [39]~~[34], [35]~~.

Reconstruction Process

In June 2012, after obtaining consent from 31 community urine collection participants, OHA began reconstructing and verifying the chain of custody from sample collection at PeaceHealth to delivery at Emory University. Forty-six of the 50 samples from consenting participants were collected at the PeaceHealth collection site in Eugene, OR. The other four samples were collected at a community hospital in Grants Pass, OR. These four samples were from two individuals who live outside the Exposure Investigation area and were excluded from further analyses in this PHA. A chain of custody was not established for those four samples.

To reconstruct and verify the chain of custody, OHA took the following steps:

1. Obtained and generated a list of PINs and PHLANs from:
    a. Copies of packing slips from packages received by the laboratory (provided by laboratory researcher on 6/12/2012);
    b. List of all consented participants with corresponding PINs and birthdates (provided by community organizers on 6/20/2012).
2. Sent PeaceHealth Client Services a list of PINs and corresponding PHLANs and birthdates

3. Obtained internal reports from PeaceHealth Client Services, Send Out Department, and Quality and Compliance to confirm the following for all 46 samples:
    a. Date and time the samples were picked up by the PeaceHealth Laboratory courier at the collection site;
    b. Date and time the samples were received at PeaceHealth's Send Out Department; and
    c. Date, time, ship-to address and method of shipment from PeaceHealth's Send Out Department to Emory University
4. Contacted Senior Operations Manager at the Rollins School of Public Health at Emory University, who confirmed the receipt of 26 samples by the CS&R at Emory University and the delivery of those 26 samples to laboratory.
5. Confirmed receipt of seven unanalyzed samples by CS&R at Emory University through the Federal Express tracking system.

Appendix F: Herbicides and Human Health

Herbicides are pesticides that are designed to be toxic to plants or specific types of plants. However, some herbicides have the potential to cause health problems in humans. In concentrated mixtures, herbicides can cause irritation to the skin and eyes if there is direct contact with these tissues. In general, the strongest scientific evidence on the health effects from herbicide exposures is from studies that examined relatively high levels of herbicide exposure. There is less certainty about the health effects of long-term exposure to lower doses, which characterizes the types of exposures the general public is most likely to experience. Some herbicides have been proven so harmful to human health that they have been banned. Others have been shown to be less toxic to humans.

Health Effects of 2,4-D and atrazine

Both 2,4-D and atrazine have the potential to harm human health. The types and severity of harm depend on the dose or how much of these pesticides get into the body. Pesticides are typically assessed for potential human health hazards based on laboratory studies in animals exposed to the pesticides via the diet and other routes of exposure. The lowest dose at which test animals show adverse effects is used as an endpoint for estimating potential risks to humans. Measurements of adverse effects are typically taken from studies of one-time or short-term exposures ("acute studies") and longer-term exposures ("chronic studies") to the pesticide.

2,4-D

In acute studies in rodents and rabbits, 2,4-D generally has demonstrated low acute toxicity via the oral, dermal, and inhalation routes of exposure. In people inadvertently exposed to 2,4-D in the short-term, the most common symptoms were dermal irritation and ocular problems. In chronic testing that serves as the basis for EPA's current human health risk assessment of 2,4-D, adverse effects observed in laboratory rats exposed to 2,4-D included gait abnormalities in a neurotoxicity study, skeletal abnormalities in pups in a developmental study, and decreased weight gain in a chronic toxicity study [64]~~[60]~~. Some studies of pesticide exposures in humans ("epidemiology studies") have found links between 2,4-D and a specific type of blood cancer called non-Hodgkin's lymphoma, but other studies have not found evidence of this link. Because 2,4-D is often mixed with other herbicides, it is difficult for scientists to tell whether 2,4-D or other herbicides in the mix might be linked to cancer. Currently, scientists don't know whether 2,4-D can cause cancer in humans [64], [65]~~[60], [61]~~. EPA is currently updating its toxicology database and risk assessments for 2,4-D through an ongoing process referred to as registration review. As part of this process, EPA is reviewing studies specifically designed to address the potential for endocrine disrupting effects from 2,4-D.

The urinary half-life of 2,4-D is 18 hours in humans [36]~~[32]~~. This is a relatively short half-life meaning that the human body rapidly eliminates 2,4-D.

Additional resources on the health effects of 2,4-D are available at the National Pesticide Information Center (NPIC): http://npic.orst.edu/factsheets/24Dgen.html

Atrazine

Adverse effects associated with laboratory animal testing with atrazine include delayed ossification of certain bones in fetuses, decreased weight gain in adults, disruption of hypothalamic function, and kidney lesions [31]~~[27]~~. Based on epidemiologic evidence, EPA has concluded that atrazine is "not likely to be carcinogenic to humans." Atrazine is an endocrine disruptor meaning that it interferes with the body's hormone system. Atrazine seems to interfere with some of the hormones that control reproduction and development of the reproductive system. At higher doses, atrazine can cause liver, kidney, and heart damage in animals. It is possible that atrazine could cause these same effects in people, although no scientific studies have examined these outcomes in humans exposed to atrazine [31], [66]~~[27], [62]~~. EPA's registration review of atrazine is scheduled to commence during 2013. As with all chemical exposures the severity and risk of health effects depends on the dose a person actually gets.

The urinary half-life of atrazine is 24-28 hours in humans [37]~~[33]~~. This is a relatively short half-life meaning that the human body rapidly eliminates atrazine. Atrazine is also rapidly metabolized into other compounds [31]~~[27]~~.

Additional resources about the health effects of atrazine can be found at the Agency for Toxic Substances and Disease registry. http://www.atsdr.cdc.gov/substances/toxsubstance.asp?toxid=59

Appendix G: ATSDR Glossary

The Agency for Toxic Substances and Disease Registry (ATSDR) is a federal public health agency with headquarters in Atlanta, Georgia, and 10 regional offices in the United States. ATSDR serves the public by using the best science available to take responsive public health actions and providing trusted health information to prevent harmful exposures and diseases related to toxic substances. ATSDR is not a regulatory agency, unlike the EPA, which is the federal agency that develops and enforces environmental laws to protect the environment and human health.

This glossary defines words used in this PHA when communicating with the public. It is not a complete dictionary of environmental health terms. If you have questions or comments, call CDC/ATSDR's toll-free telephone number, 1-800-CDC-INFO (1-800-232-4636).

Absorption:	How a chemical enters a person's blood after the chemical has been swallowed, has come into contact with the skin, or has been breathed in.
Acute Exposure:	Contact with a chemical that happens once or only for a limited period of time. ATSDR defines acute exposures as those that might last up to 14 days.
ATSDR:	The **A**gency for **T**oxic **S**ubstances and **D**isease **R**egistry. ATSDR is a federal health agency in Atlanta, Georgia that deals with hazardous substance and waste site issues. ATSDR gives people information about harmful chemicals in their environment and tells people how to protect themselves from coming into contact with chemicals.
Background Level:	An average or expected amount of a chemical in a specific environment or amounts of chemicals that occur naturally in a specific environment.
Cancer:	A group of diseases that occur when cells in the body become abnormal and grow, or multiply out of control.
Carcinogen:	Any substance shown to cause tumors or cancer in experimental studies.
Chronic Exposure:	A contact with a substance or chemical that happens over a long period of time. ATSDR considers exposures of more than one year to be *chronic*.
Completed Exposure Pathway:	See **Exposure Pathway**.
Comparison Value: (CVs)	Concentrations of substances in air, water, food, and soil that are unlikely, upon exposure, to cause adverse health effects. Comparison values are used by health assessors to select which substances and environmental media (air, water, food and soil) need additional evaluation while health concerns or effects are investigated.
Concern:	A belief or worry that chemicals in the environment might cause harm to people.

Concentration:	How much or the amount of a substance present in a certain amount of soil, water, air, or food.
Contaminant:	See **Environmental Contaminant**.
Dermal Contact:	A chemical getting onto your skin. (See **Route of Exposure**).
Dose:	The amount of a substance to which a person may be exposed, usually on a daily basis. Dose is often explained as "amount of substance(s) per body weight per day".
Environmental Contaminant:	A substance (chemical) that gets into a system (person, animal, or the environment) in amounts higher than the **Background Level**, or what would be expected.
Environmental Media:	Usually refers to the air, water, and soil in which chemicals of interest are found. Sometimes refers to the plants and animals that are eaten by humans. Environmental Media is the second part of an **Exposure Pathway**.
U.S. Environmental Protection Agency (EPA):	The federal agency that develops and enforces environmental regulations to protect human health and the environment.
Exposure:	Coming into contact with a chemical substance. (For the three ways people can come in contact with substances, see **Route of Exposure**.)
Exposure Pathway:	A description of the way that a chemical moves from its source (where it began) to where and how people can come into contact with (or get exposed to) the chemical. ATSDR defines an exposure pathway as having 5 parts: 1. Source of Contamination, 2. Environmental Media and Transport Mechanism, 3. Point of Exposure, 4. Route of Exposure, and 5. Population (Receptor). When all 5 parts of an exposure pathway are present, it is called a **Completed Exposure Pathway**. When additional information is needed on one or more of the five parts, it is called a **Potential Exposure Pathway**. Each of these 5 terms is defined in this Glossary.
Frequency:	How often a person is exposed to a chemical over time; for example, every day, once a week, or twice a month.

Ingestion:	Swallowing something, as in eating or drinking. It is a way a chemical can enter your body (See **Route of Exposure**).
Inhalation:	Breathing. It is a way a chemical can enter your body (See **Route of Exposure**).
kg	Kilogram or 1000 grams. Usually used here as part of the dose unit mg/kg/day meaning mg (contaminant)/kg (body weight)/day.
µg	Microgram or 1 millionth of 1 gram. Usually used here as part of the concentration of contaminants in water (µg/Liter).
mg	Milligram or 1 thousandth of 1 gram. Usually used here as in a concentration of contaminant in soil mg contaminant/kg soil or as in the dose unit mg/kg/day meaning mg (contaminant)/kg (body weight)/day.
MRL:	**M**inimal **R**isk **L**evel. An estimate of daily human exposure – by a specified route and length of time -- to a dose of chemical that is likely to be without a measurable risk of adverse, noncancerous effects. An MRL should not be used to predict adverse health effects.
~~NPL~~	~~The National Priorities List for Uncontrolled Hazardous Waste Sites. EPA's list of the most serious uncontrolled or abandoned hazardous waste sites in the United States. The NPL is updated on a regular basis.~~
PHA:	**P**ublic **H**ealth **A**ssessment. A report or document that looks at chemicals at a hazardous waste site and tells if people could be harmed from coming into contact with those chemicals. The PHA also tells if possible further public health actions are needed.
Point of Exposure:	The place where someone can come into contact with a contaminated environmental medium (air, water, food or soil). Some examples include the area of a playground that has contaminated dirt, a contaminated spring used for drinking water, or the backyard area where someone might breathe contaminated air.
Population:	A group of people living in a certain area or the number of people in a certain area.
Potential Exposure Pathway:	See **Exposure Pathway**.
Public Health Assessment(s):	See **PHA**.

Reference Dose (RfD): An estimate, with safety factors (see **safety factor**) built in, of the daily, lifetime exposure of human populations to a possible hazard that is not likely to cause harm to the person.

Route of Exposure: The way a chemical can get into a person's body. There are three exposure routes:
– breathing (also called inhalation),
– eating or drinking (also called ingestion), and
– getting something on the skin (also called dermal contact).

Source (of Contamination): The place where a chemical comes from, such as a landfill, pond, creek, incinerator, tank, or drum. Contaminant source is the first part of an **Exposure Pathway**.

Special Populations: People who may be more sensitive to chemical exposures because of certain factors such as age, a disease they already have, occupation, sex, or certain behaviors (like cigarette smoking). Children, pregnant women, and older people are often considered special populations.

~~Superfund Site:~~ ~~See NPL.~~

Toxic: Harmful. Any substance or chemical can be toxic at a certain dose (amount). The dose is what determines the potential harm of a chemical and whether it would cause someone to get sick.

Toxicology: The study of the harmful effects of chemicals on humans or animals.

Safety Factor Mathematical adjustments for reasons of safety when knowledge is incomplete. For example, factors used in the calculation of doses that are not harmful (adverse) to people. Safety factors are used to account for variations in people's sensitivity, for differences between animals and humans, and for differences between effect levels. Scientists use safety factors when they have some, but not all, the information from animal or human studies to decide whether an exposure will cause harm to people [also sometimes called an uncertainty factor].